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MUSEUM GATE HOUSE—From the Lawn.

# MISSOURI

# BOTANICAL GARDEN.

## FIFTEENTH ANNUAL REPORT.

ST. LOUIS, MO.:
PUBLISHED BY THE BOARD OF TRUSTEES.
1904.

# MISSOURI

# BOTANICAL GARDEN.

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# BOARD OF TRUSTEES OF THE MISSOURI BOTANICAL GARDEN.

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Mayor of the City of St. Louis.*

CALVIN M. WOODWARD,[4]
President of the Board of Public Schools of St. Louis.*

A. D. CUNNINGHAM, Secretary.

**Ex-officio.*

1 Elected November 11, 1903, to fill the vacancy caused by the death, on October 6th, of Dr. J. B. Johnson, one of the Trustees named by Mr. Shaw.

2 Elected November 11, 1903, to fill the vacancy caused by the death, on June 9th, of Mr. Joseph Branch, one of the Trustees named by Mr. Shaw.

3 Elected President of The Academy of Science, February 1, 1904, to succeed Mr. Henry W. Eliot, who had held that office for two years.

4 Elected President of the Board of Public Schools of St. Louis, October 13, 1903, to succeed Dr. William Taussig, who had held that office for one year.

## PREFACE.

Under direction of the Board of Trustees, the fifteenth annual report of the Missouri Botanical Garden is presented to the public.

The fourteenth volume was issued on October 8th, 1903, on which date separates of Mr. Rehder's monograph of Lonicera were also distributed.

These reports are sent to scientific institutions and journals in exchange for publications or specimens desirable for the Garden, and, when possible, reprints of the botanical articles they contain are presented to botanists occupied with a study of the subjects they refer to. Any of the Garden publications not out of print may be purchased at approximately the cost of publication from A. I. Eriksson, Tufts College, Mass.; R. Friedländer & Sohn, Berlin, Germany; W. Wesley & Son, London, England; or the undersigned.

William Trelease.

St. Louis, Mo., February 15, 1904.

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# REPORTS FOR THE YEAR 1903.

## REPORT OF THE OFFICERS OF THE BOARD.

SUBMITTED TO THE TRUSTEES JANUARY 13, 1904.

*To the Board of Trustees of the Missouri Botanical Garden:*

We are sorry to again announce the loss of two of the original members of the Board, appointed by Mr. Shaw: Mr. Joseph W. Branch, who died on June 9th, 1903, and Dr. John Bates Johnson, on October 6th, 1903.

The following memorials were adopted by the Board and ordered entered upon its records:—

### IN MEMORIAM — JOSEPH W. BRANCH.

In the death of Mr. Joseph W. Branch, the Trustees of the Missouri Botanical Garden mourn the loss from their number of an active and useful associate.

Appointed originally and personally by Mr. Shaw himself, and by birth a fellow townsman of his, he had served faithfully from the beginning of the existence of the Board. Of those original personal appointments only four survive.

Mr. Branch, during all the years of his service, took studious pains to be present at the monthly meetings of the Board. In those meetings a sturdy standing on his part for what he thought right, or what he conceived to be the duty of the Board, was witnessed more than once. His surviving associates desire to give permanent record to their sense of bereavement in his death, and to their grateful appreciation of the qualities of character which contributed to the helpful and efficient work which he wrought by their side.

Along with this minute to be preserved, they ask leave to send their condolences to be mingled with the tears of the afflicted family and home, over the going away from human sight of one who after more than three score and ten years of arduous toil now rests from his labors.

IN MEMORIAM — DR. JOHN BATES JOHNSON.

Dr. John Bates Johnson died October 6th, 1903, at the age of eighty-six years.

Born at Fairhaven, Mass., educated at Harvard University, he came to St. Louis in 1841. He was appointed an instructor in medicine in 1846, and from that time until his death he had an important part in medical education and in the practice of his profession.

He was a member of the Western Sanitary Commission during the Civil War, and in that position he rendered inestimable services in alleviating the sufferings of those who participated in that struggle.

He was appointed by Mr. Shaw one of the original members of this Board, and until failing health made it impossible, he was always present at its meetings. His sound common sense, his hearty sympathy with the work of this Board, his unfailing courtesy and kindness, his genial appreciation of the work of others, won the respect and affection of every member of this Board. We mourn his loss as that of a strong, faithful, public-spirited citizen, an ideal trustee of a public charity, a warm and constant friend. His life was long, his labors were constant and great, his friendships were numerous and lasting — his work was done.

May he rest in peace.

It became necessary in January last, to retire Mr. James Gurney, as Head Gardener, on account of advancing age after about thirty-seven years' connection with the Garden, although he is still associated with it.

The Board, as a slight recognition of the valuable services rendered by Mr. Gurney for so many years, adopted the following resolution, which, by order of the Board, was engrossed and presented to him:—

TESTIMONIAL — JAMES GURNEY.

Years roll by for the race, and age creeps on for individuals. Nor can anything human stay the course of either.

The eloquence of a Cicero may reason about the fact of old age and the voice of the Sacred Psalmist may seek to sing content into the heart in spite of it, but steadily on it comes if life is spared, and it cannot be evaded.

Facing this fact of human experience, Mr. James Gurney, the long time superintendent of the daily activities of the Missouri Botanical Garden, feels obliged to withdraw from the pressing cares and responsibilities of such a post.

Remembering that Mr. Gurney served long under the eyes and personal direction of Mr. Shaw himself, and that now for near forty years he has labored in the Garden guiding its work, the Board of Trustees desires

hereby to return to Mr. Gurney, and to order of record on its minutes, the expression of its grateful appreciation of his long and faithful services, its request that he will still remain connected with the Garden under the honorable title of "Head Gardener Emeritus," accorded to him, and its earnest wishes for health and peace and happiness to attend and crown the well-earned rest of his evening tide of life.

We herewith submit for your consideration the financial results for the year ending December 31st, 1903.

The income from rentals for the past year has exceeded the former year $3,008.88 and in view of the large and steadily growing demand for commercial buildings, at increased rentals, we have been able in many instances to secure decided advances and a further increase of $9,000.00 over last year is anticipated.

We were enabled to dispose of a piece of property located at Main and Vine streets, for terminal purposes, for $62,500.00 and have invested $42,690.08 of the amount in the erection of a large six story factory building at the corner of Main and Market streets, which was finished in August and was at once occupied, on a long lease at a profitable rental.

We have disposed of only one lot of ground, 70 feet, on Flora Boulevard, during the year, upon which a residence costing $17,000.00 is now being erected, but we are negotiating for further sales on the same street.

The large sewer on Thurman avenue, which serves much of the residence land belonging to the Board, has been finished, and our portion of the cost, $11,600.00, will be paid during the present month. Other sewers are either under construction, or being planned, which will, during the next two years, necessitate an additional expenditure on the part of the Board of not less than $35,000.00.

Necessary repairs have been made to the buildings belonging to the Board, and in one case $6,355.33 was expended in reconstructing a building; and the properties of the Board are in fairly good condition and all are occupied.

No permanent extensive improvements were made at the

Garden outside of necessary repairs to the buildings and plant houses, but large additions have been made to the collection of plants and shrubs, in the planting of the addition to the Garden known as the North American Synopsis.

The annual bequests provided for in Mr. Shaw's will were carried out with the exception of premiums for a flower show (none having been held) at the expense of $2,745.82.

A number of additions have been made to the library and herbarium by purchase and gift, during the past year, and the following amounts have been credited to the Stock Account: —

| | |
|---|---|
| Library | $3,807 18 |
| Herbarium | 5,616 20 |

A largely increased expenditure for improvements to property, an excess of $4,000.00 over the previous year for taxes, as well as the increased cost of repairs, insurance, and $4,468.92 expended for improvements at the Garden, made serious inroads upon our revenue for the year, but we are enabled to carry forward a surplus of receipts over expenditures of $1,127.06.

For further information concerning the operations at the Garden, you are referred to the Director's annual report.

RECEIPTS.

| | | |
|---|---|---|
| Rents | $109,635 99 | |
| Interest and dividends | 3,664 34 | |
| Garden pasturage, above expenses | 502 94 | |
| Garden handbook sales | 56 25 | |
| Publication sales | 19 58 | |
| Total income | $113,879 10 | |
| Loss by fire to buildings | 5,814 14 | |
| Loss by fire to rents | 311 11 | |
| Sales of real estate | 61,500 00 | |
| Sales of real estate under decree of Court | 1,000 00 | $182,504 35 |
| Cash on hand January 1st, 1903 | | 7,248 66 |
| Total receipts | | $189,753 01 |

EXPENDITURES.

| | | |
|---|---|---|
| Garden Account, | | |
| Labor pay-roll | $18,380 87 | |
| Student pay-roll | 1,438 87 | |
| Office assistance | 1,098 24 | |
| Fuel | 1,736 23 | |
| Water | 191 00 | |
| Repairs and supplies | 2,657 72 | |
| Stable and implements | 37 55 | |
| Plants and seeds | 1,732 00 | $27,272 48 |
| Herbarium Account, | | |
| Salaries | 410 80 | |
| Fuel | 77 91 | |
| Current expenditures | 2,596 98 | 3,085 69 |
| Library Account, | | |
| Salaries | 1,089 17 | |
| Fuel | 77 91 | |
| Current expenditures | 3,072 77 | 4,239 85 |
| Office Account, | | |
| Salaries | 4,621 60 | |
| Fuel | 77 94 | |
| Current expenditures | 626 44 | 5,325 98 |
| Research Account, | | |
| Salaries | 569 96 | |
| Drawing plates | 65 50 | |
| Current expenditures | 332 22 | 967 68 |
| Scholarship Account, | | |
| Instruction | 723 90 | |
| Care of Lodge | 240 00 | |
| Fuel | 83 82 | |
| Current expenditures | 260 15 | 1,307 87 |
| Total maintenance expenditure | | $42,199 55 |
| Garden Improvement Account, | | |
| Planting and improving garden extension | 1,792 10 | |
| Growing houses | 162 25 | |
| Chemical laboratory | 481 17 | |
| Restoring plants and plant houses damaged by fire | 2,033 40 | 4,468 92 |
| Total amount expended on Garden | | $46,668 47 |
| Publication Account, | | |
| Fourteenth Annual Volume | 1,849 16 | 1,849 16 |
| Property Expense, | | |
| State, school, city and sprinkling tax | 34,743 98 | |
| Streets, sidewalks and sewers | 4,498 77 | |
| *Carried forward* | $39,242 75 | $48,517 63 |

| | | |
|---|---|---|
| *Brought forward* | $39,242 75 | $48,517 63 |
| Opening streets | 916 00 | |
| Insurance | 5,589 01 | |
| Repairs | 3,777 54 | |
| Improvements | 6,741 53 | 56,266 83 |
| Office Expenses, | | |
| Salaries | 4,200 00 | |
| Office rent | 900 00 | |
| Printing, postage, telephone, etc. | 684 81 | 5,784 81 |
| Bequests, | | |
| Flower Sermon | 200 00 | |
| Trustees' Annual Banquet | 1,954 60 | |
| Gardeners' Annual Banquet | 338 22 | |
| Shaw School of Botany | 253 00 | 2,745 82 |
| Sundries, | | |
| Legal expenses | 1,121 96 | |
| Repairs to buildings damaged by fire | 5,089 74 | |
| Commission | 1,799 20 | |
| New buildings | 40,740 08 | 48,750 98 |
| Bonds, stocks and certificates | 20,937 50 | 20,937 50 |
| Total expenditure | | $183,003 57 |
| Cash on hand December 31st, 1903 | | 6,749 44 |
| | | $189,753 01 |

Respectfully submitted,

R. J. LACKLAND, President.

Attest:

A. D. CUNNINGHAM, Secretary.

BROMELIAD HOUSE—Air Plants.

# FIFTEENTH ANNUAL REPORT OF THE DIRECTOR.

SUBMITTED TO THE TRUSTEES JAN. 13, 1904.

*To the Board of Trustees of the Missouri Botanical Garden:*

The following report on the Missouri Botanical Garden and the School of Botany therewith connected is respectfully submitted in compliance with the rules of the Board. As was done with my tenth report,* this, which marks the passage of another convenient period of time, is made to present a resumé of progress.

Briefly stated, the broad purposes of the founder of the Garden, as indicated in his will,† were to maintain an attractive and instructive garden easily accessible to the public; to secure its utilization for research in botany, horticulture, vegetable pathology and allied sciences by equipping it with herbarium, library and laboratory conveniences; to educate capable gardeners; and to promote a general knowledge of botany, both pure and applied.

For the furtherance of these purposes, the Board of Trustees, on its organization, adopted the following general rules‡ for the guidance of the Director in planning and carrying out the work intrusted to him: —

1. To continue or even augment the present ornamental features of the garden.

2. To add to its botanical usefulness and interest by the introduction as opportunity offers of plants representative of the American flora, so that, other things being equal, these shall be largely represented and may even preponderate outside of the greenhouses, giving, then, in the garden, an epitome of the leading characteristics of our native flora.

3. To carry into execution, as rapidly as possible, a system of correctly naming and labeling all plants in the garden with the exception of such

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* Rept. Mo. Bot. Gard. **10**: 12.

† Rept. Mo. Bot. Gard. **1**: 29. — See also Popular Science Monthly. **62**: 193.

‡ Rept. Mo. Bot. Gard. **1**: 93.

as may be used in ribbon-gardening or for other exclusively ornamental purposes.

4. To provide fire-proof quarters for the invaluable herbarium of the late Dr. George Engelmann, and to immediately mount it in the proper manner so as to insure its preservation and availability for scientific use. Also, to provide for and add to the general herbarium (based on that of Bernhardi) now at the garden with the special object of ultimately making it complete in good representatives of American plants.

5. To arrange, bind, and index the books and pamphlets at the garden. Also, to provide more ample but equally safe accommodations for the library, to bring it up to date as rapidly as possible, to enter subscriptions for periodical publications, and to keep it abreast of the times, and in the most useful form, by the purchase of important publications, as they shall appear, and by the proper indexing of periodicals and pamphlets.

6. To secure a botanical museum, containing material needed for study or calculated to advance general or special knowledge of botany.

7. To direct the main energy of research for the present toward assisting in the completion of a systematic account of the flowering plants of North America, by the publication of monographs of different Orders and Genera, illustrated when this may seem desirable; and to specially cultivate representatives of such groups for purposes of study.

8. To gradually acquire and utilize facilities for research in vegetable histology and physiology, the diseases and injuries of plants, and other branches of botany and horticulture, as special reason for developing one or the other may appear.

9. To make the facilities of the garden useful in botanical and horticultural instruction, as they increase and opportunity for such work appears: meantime, in all feasible ways, to attract to the School of Botany students of promise, and to provide for their instruction and the best use of their time as investigators.

10. To take steps looking to the appointment of six "garden pupils," — youths with at least an elementary English education, who shall be regarded as apprentices in the garden, working under the direction of the head gardener and foreman, and shall hold scholarships yielding $300.00 per year each, together with free lodging near or in the garden, and free tuition in the School of Botany; and who, after having worked for six or more years (as shall ultimately prove best*) in the different departments of the garden, and proved proficient in its practical work, may be admitted to examination for a certificate of proficiency in the theory and practice of gardening.

11. To have in mind, in appointing associates for the Director, their special aptitude in some one of the branches indicated above, so that

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* This time was subsequently reduced to four years. — Rept. Mo. Bot. Gard. 4 : 17.

with each appointment the efficiency of the institution for instruction and original work may be broadened and increased.

I am pleased to have been able to show each year, and to emphasize in the contrast afforded by this quinquennial summary, individual progress in nearly all of these specifically named directions, and gratifying collective advance in achieving the broad purpose of the founder of the Garden.

## ORNAMENTAL FEATURES.

The testimony of visitors shows that there is popular appreciation of the growing beauty of the Garden in which, though the area under cultivation for floricultural purposes has not been enlarged, varied planting alone makes a new impression of beauty each year, which is justified in fact by the yearly selection of more decorative species for planting. A large and continuing increase in the collections of certain kinds of tender plants, especially orchids and bromeliads, makes this even truer of the plant houses than of the open-air plantations, while the provision of more and better growing-houses enables the gardeners to keep up a more uninterrupted succession of winter blooming plants in the main houses with the passage of each year. In one detail only, is the Garden less beautiful than when it came under the care of the Board, — for the ravages of the tornado of 1896 among the trees are repaired but slowly, although each year sees a betterment in this respect.

During the year just closed, 405 consignments, comprising 66,790 plants or packets of seeds, were received for growth at the Garden. Of these, 4,221, valued at $369.85, were collected, and 24,310, valued at $1,701.70 were propagated by employees, the two comprising 58 of the 405 entries; 6,103, representing 208 consignments and valued at $707.35, were presented or received in exchange for

material or publications from the Garden; and 32,156, representing 139 entries, for which $3,032.18 was expended, were purchased. Of this expenditure, $1,300.18 was for plants for the North American tract.

Among the notable gifts of the year should be mentioned four magnificent Hawaiian tree-ferns, presented by Mr. James Gibb, whose interest was secured through Mr. Jared G. Smith, a former Assistant at the Garden; two tree-ferns, presented by Dr. J. C. Willis, Director of the botanical garden at Peradeniya, Ceylon; a mature staminate

DIAGRAM A.

CONSIGNMENTS OF PLANTS.

plant of *Cycas revoluta*, presented by Mr. W. T. James of Bermuda; and 78 orchids, presented by the New York Botanical Garden.

The number of consignments of plants since 1898, with the average for the last five years, is presented on the accompanying diagram, which shows two periods of unusual activity, the first, in 1900, due to the energy of Mr. P. T. Barnes, then Plant Recorder at the Garden, and the second, in 1903, largely a result of the energy of the Superintendent, Mr. H. C. Irish.

In 1898 the number of distinct species and varieties cultivated was found by inventory to be 8,009.* At the end of each subsequent year those reported as dropped from cultivation and those known to have been added have been footed up, and the net gain for the year noted.† For 1903, the records show a loss of 521 and an addition of 1,573, or a net increase for the year of 1,052.

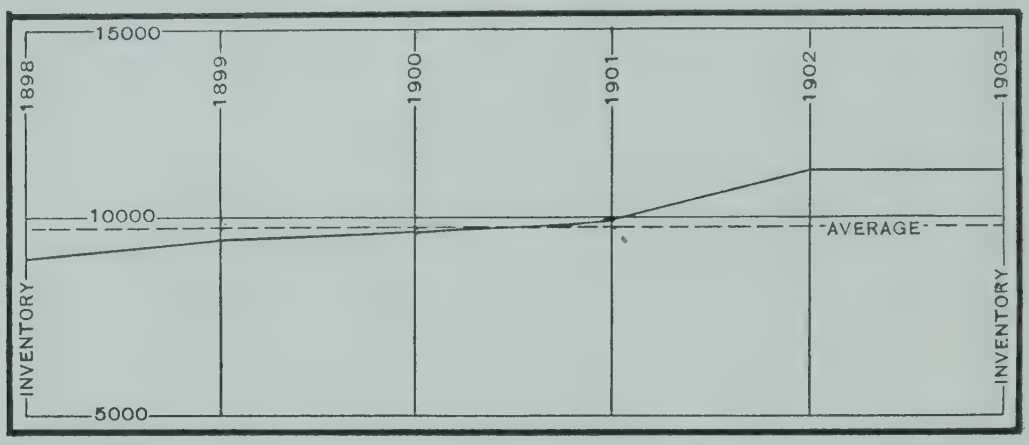
It is difficult, however, to keep close track of the annuals dropped from cultivation, or to get gardeners always to report the loss of what are intended to be permanent plants, so that a quinquennial or other inventory is essential for the periodical correction of the records. Such an inventory, taken at the end of 1903, shows that 11,357 species and varieties are now actually in cultivation at the Garden. This number is 1,246 less than that given by the records (12,603) and even 184 less than the summary of records gave at the end of 1902,‡ — the difference between the recorded and inventoried totals representing the accumulated errors of the records for five years. The verified increase of 3,348 shown by comparing the inventory summary of 1898 with that of 1903 is 41.8 per cent of the total at the end of 1898, or an average of about 8 per cent for each of the last five years. The average number for the past five years is 9,683, or almost double the number estimated to be in cultivation in 1895.§ The diagram on the following page shows the yearly growth in species and varieties cultivated.

As in previous years, plants and seeds which could be spared have been sent to exchanging institutions and to investigators who have needed them for purposes of study, this distribution for 1903 reaching 506 plants and 95 packets of seeds, collectively valued at $92.65. Surplus

* Rept. Mo. Bot. Gard. **10**: 15.
† Rept. Mo. Bot. Gard. **11**: 13. **12**: 13. **13**: 18. **14**: 15.
‡ Rept. Mo. Bot. Gard. **14**: 15.
§ Rept. Mo. Bot. Gard. **7**: 14.

decorative plants, including those removed from the beds at the approach of winter, as heretofore have been dis-

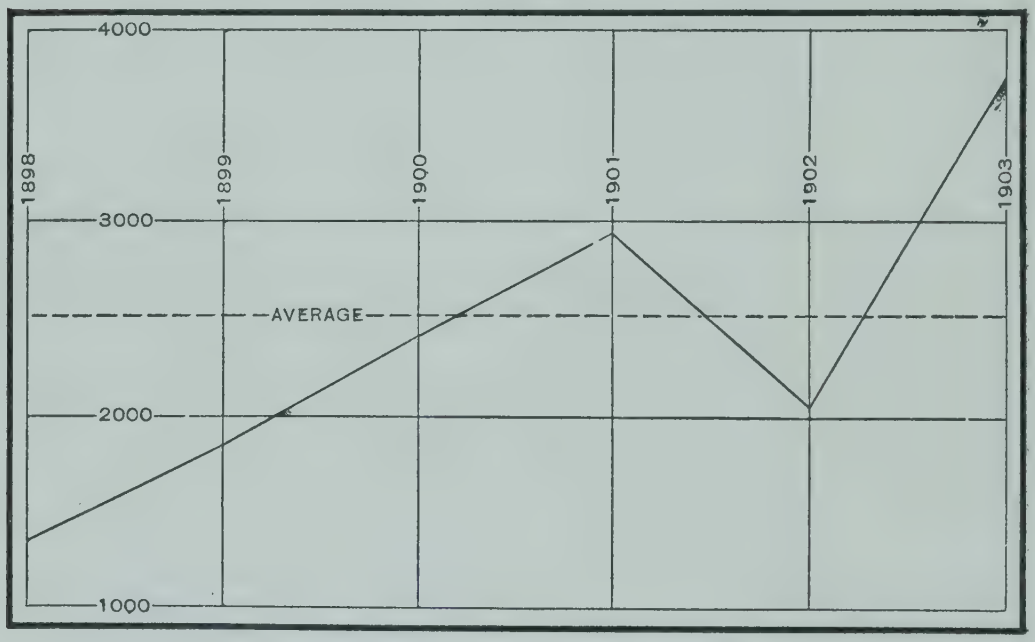
DIAGRAM B.




SPECIES AND VARIETIES CULTIVATED.

tributed to schools, hospitals, etc., the total of such distributions for the year being 3,682, and the average for each of the last five years, 2,581.

DIAGRAM C.

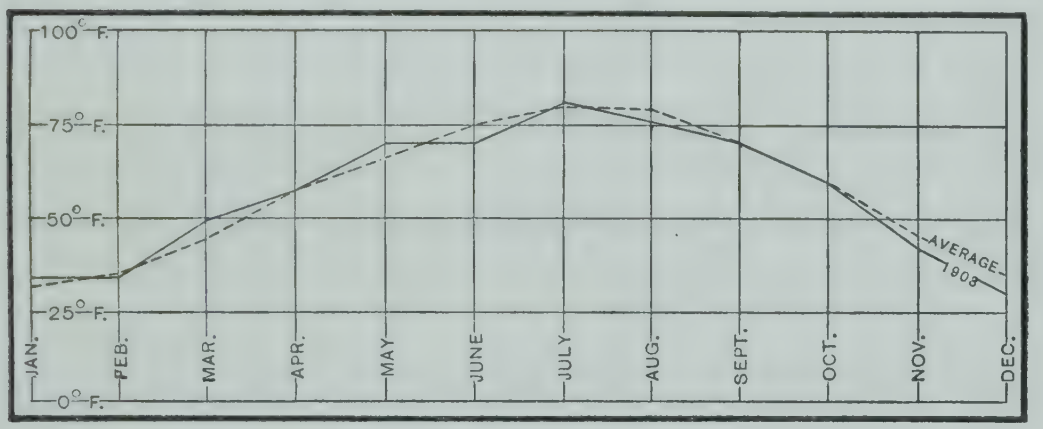



SURPLUS PLANTS DISTRIBUTED.

As shown by the local meteorological summary of the Weather Bureau, the temperature of the year has agreed

closely with the average for the 33 years covered by records, the daily mean being .4° F. below the average, for the entire year. The close seasonal comparability of the monthly means with the average is shown by the accompanying diagram, June, alone, of the open months having been sufficiently (5° F.) below the average to appreciably interfere with the customary luxuriant growth of bedding plants, and such aquatics as *Victoria*.

DIAGRAM D.

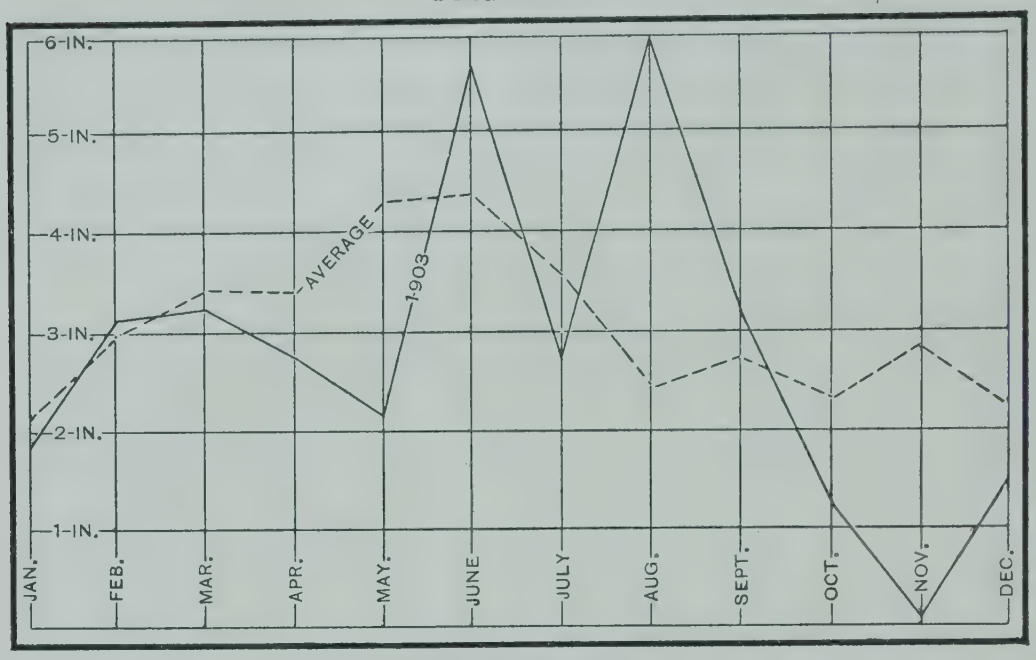



MEAN TEMPERATURES.

The accompanying precipitation curve for the year, with average curve for the past 33 years, shows much greater deviation from the normal as represented by averages. The total precipitation for the year, as shown by the same records, is 3.39 in. less than the average. As the diagram shows, much of this deficiency in rainfall occurred in the spring and autumn months, so that it interfered materially with the successful transplantation of trees and shrubs at both seasons. It has proved possible, however, to maintain the decorative features of the Garden in a more than usually attractive manner through the entire open season.

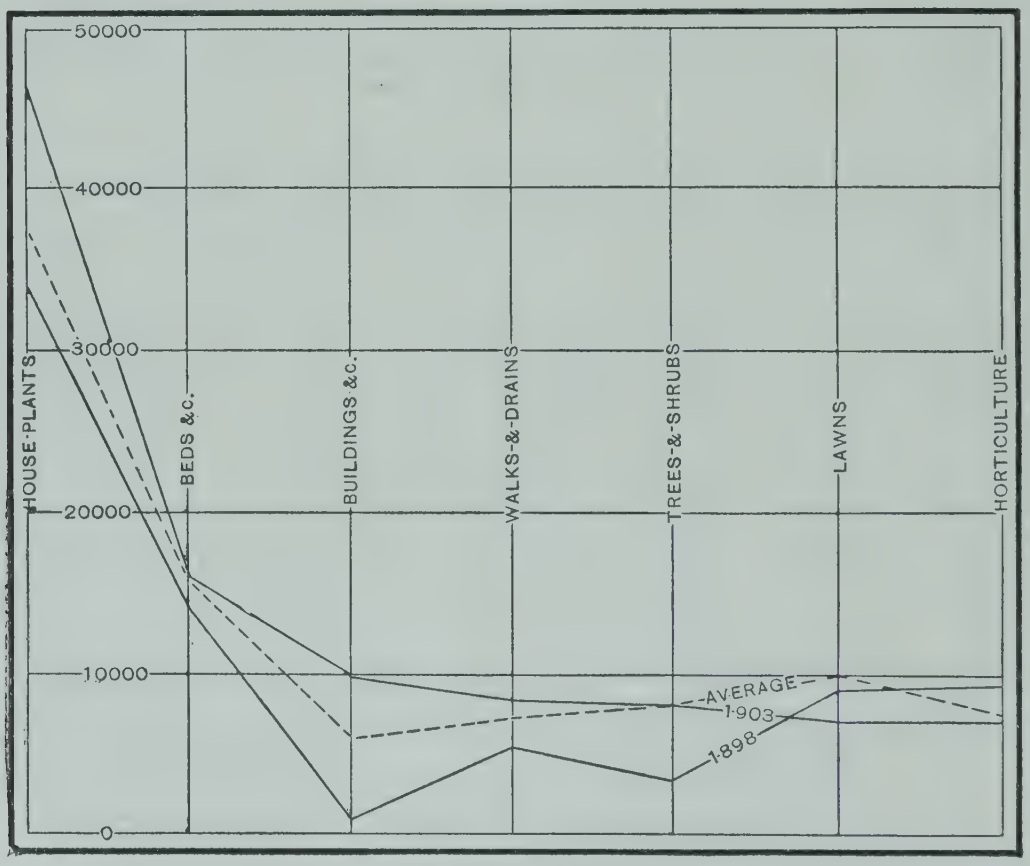
The distribution of labor through the several departments of the Garden is shown by the accompanying diagram, which clearly brings out the increased time devoted to plants

DIAGRAM E.




PRECIPITATION.

DIAGRAM F.




HOURS OF LABOR.

cultivated under glass incident to the recent increases in plant houses; the better care that walks, buildings, fences, and other structures are now receiving; the increased labor demanded by trees and shrubbery since the planting of the North American tract; and the reduced expense of horticultural work. A considerable yearly fluctuation in labor required on the walks and lawns is largely connected with seasonal differences in precipitation.

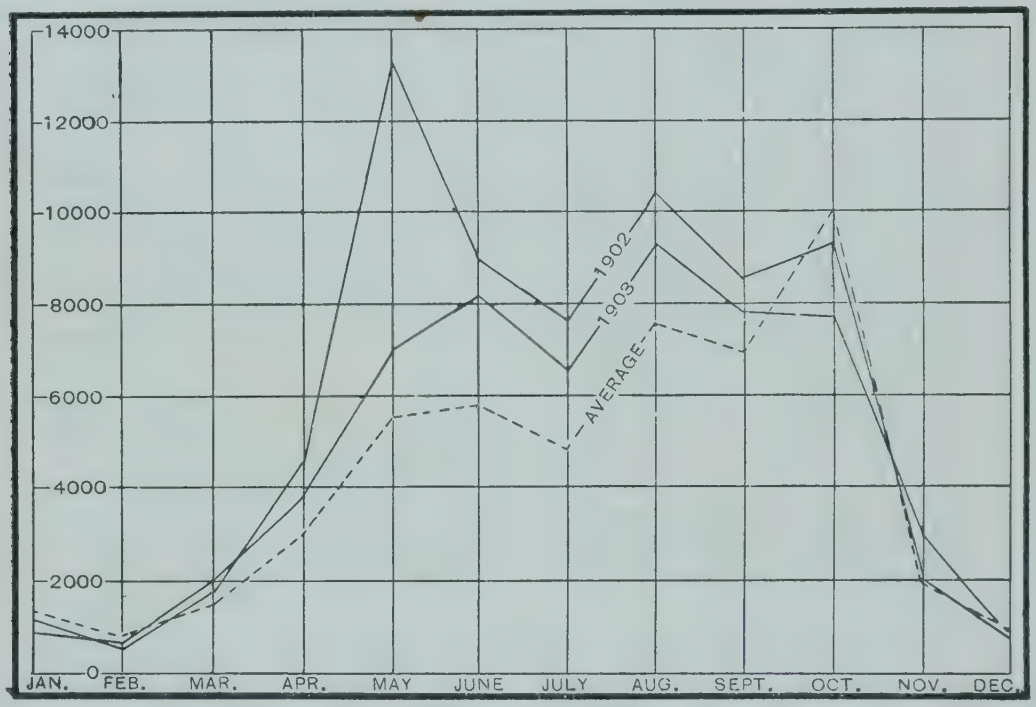
Toward the end of the year, a fire, which originated from a defective flue in the boiler pit from which the newer range of plant houses is heated, damaged the adjacent structures to the extent of about $1,000.00. It chanced that about this point, in the hot and intermediate houses, were clustered most of the orchids and Platyceriums, and many other choice plants, and although the efficient service of the fire department reduced the loss on the buildings to an inconsiderable sum, the heat and smoke destroyed a large part of these collections and so seriously injured the remainder that their recovery is likely to be at best a matter of several years' time. By the prompt action of the Board, however, I have been enabled to replace these collections by other plants of the same or equally decorative species, and it is expected that the early spring will find the orchid collection as large, varied and interesting as before the fire. In connection with this loss, I wish to record my appreciation of the courteous action of the New York Botanical Garden, the Director of which, Dr. N. L. Britton, immediately offered us such duplicates as could be spared from its collections; and a consignment of 80 plants, representing 78 species of orchids, was received from this source as soon as the buildings were sufficiently repaired for their reception.

## VISITORS.

The total number of persons who visited the Garden in 1903 was 79,039, of whom 10,516 were recorded for the

open Sunday afternoon in June, and 10,692 for that in September, leaving 57,831 for the week-days of the year. The total for the year has been exceeded twice since records have been kept: in 1901, when 91,262 visitors were reported, and in 1902, when 112,314 were counted. In each of these years the visitors on the two Sunday afternoons when, under Mr. Shaw's will, the Garden is opened, were nearly twice as numerous as in 1903. The

DIAGRAM G.




VISITORS ON WEEK-DAYS.

number of week-day visitors has been passed once, in 1902, when an unusual interest in the Garden was aroused in May,* but except for that year it is greater than shown by any other record.

The distribution of week-day visitors through the season is indicated on the accompanying diagram, on which, for comparison, are placed the curve for 1902 and the average

* Rept. Mo. Bot. Gard. **14**: 17.

NORTH AMERICAN TRACT—Cat-tails and Water.

curve for the entire period covered by records with the exception of the aberrant year 1902.

This diagram is interesting as showing the increased number of visitors during the open season, in comparison with the average for years prior to 1902; the great increase during the latter year, for which reasons were assigned in my last report; the small but still noticeable effect produced by special attractions out of the spring or summer, as indicated by the slight rise in the curve for November, at which time a display was made of several thousand plants representing some 300 carefully selected and well-grown varieties of chrysanthemums; and the falling off of country visitors attracted by the St. Louis Fair in October, of whom, formerly, two or three thousand flocked to the Garden on a single day, when the weather was favorable. Except for the November aberration, this curve for 1903 may be taken as a fair representation of the normal seasonal distribution of visitors, who reach their smallest number in the coldest month, February, gradually increase until August, when out-of-door life in this latitude is at its maximum — except for July, during which month the exodus from the city and the sense of heat discomfort are greatest, and come in lessening numbers as the cool weather of autumn sets in, the falling off being very rapid after the bedding plants have been destroyed by frost, usually late in October.

The appended diagram summarizing the Sunday visitors shows once more very clearly the great fluctuation in numbers from year to year and the consequent influence of the records for these two open Sunday afternoons on the totals for any given year.

## NATIVE PLANTS.

When established, the new synoptical tract of some twenty acres, devoted exclusively to North American

plants,* is expected to be not only instructive but one of the most attractive parts of the Garden, its configuration being good and the treatment that of an open park in which a liberal use of hardy perennials will afford desirable color. Nearly all of the material needed for this plantation is now

DIAGRAM H.

SUNDAY VISITORS.

in place, and the tract is supplied with water and drainage facilities; but a succession of trying winters has held back the development of the trees to such an extent that the landscape effect of the planting will not be realized for several years yet. Though an essential part of the emphasis

* Rept. Mo. Bot. Gard. **8**: 38. **9**: 13. **10**: 14. **11**: 14. **12**: 12. **14**: 14.

of the plan of planting — which exemplifies the sequence of Orders in the Bentham and Hooker classification, the walks in this part of the grounds have not yet been made, and are not likely to be constructed until the trees are well developed and increasing resort to this collection indicates a need of them, since it is thought better to afford the comfort of a turf walk through the grounds as long as possible, than to provide at once the harder artificial paths that will ultimately be necessary.

### NAMING AND LABELING PLANTS.

One of the most important and difficult features of museum administration is the provision of adequate labels with the specimens that are displayed. A collection of living plants is essentially a museum collection, but the difficulty of naming and labeling them is far greater than in the case of a museum in the ordinary sense — where they may be kept under lock and key, or of a zoological garden in which the number of both species and individuals is relatively small while the latter are usually large and of sufficient individual value to lead to the prompt replacement of those which may die. The naming of collections in gardens of any size is notoriously bad, except for the relatively few that are being critically studied, and the Missouri Botanical Garden is probably not much better or worse than comparable institutions; but an effort has been made from the first to see that each plant or clump of plants is provided with a legible label giving its common name, the scientific name under which it was received — standardized by the Index Kewensis where possible, its geographical range, and a key number by which its individual history may be traced in the office records.* In this way, if the name has been correctly ascertained, sufficient information is given on a small and unobtrusive label to

* Rept. Mo. Bot. Gard. **6**: 14, 15.

enable a person interested to obtain further information by reference to easily accessible books, or to order a desirable species from dealers in case he wishes to procure it for cultivation.

## THE HERBARIUM.

Though the maintenance force in the herbarium has been kept always at the minimum consistent with the preservation of the collections in a reasonably usable condition, uninterrupted if fluctuating growth has been noted each year. In 1903, 37,408 specimens were incorporated. Of these, 3,964, valued (unmounted) at $198.20, were presented or received by way of exchange; 9,020, valued at $451.00, were collected by employees of the Garden; 701 were cryptogams belonging to the Bernhardi herbarium, bought many years before his death by Mr. Shaw;* and 24,424 were purchased. The expenditure for the year on herbarium specimens and supplies was $2,596.98. Among the collections incorporated this year were 3,014 sheets collected by the Director in Madeira, Alaska, etc., 3,098 from the Chapman collection, 1,261 from the Broadhead herbarium, 1,750 of Krieger's Saxon fungi, 1,350 of Rabenhorst's European mosses and 59 Engelmann sheets. Duplicate material to the extent of 1,074 specimens, valued at $53.70, was distributed to correspondents in 1903.

The total number of specimens in the herbarium is now 465,205, an increase of 157,745, or 51.3 per cent, over the number reported at the end of 1898.† As is shown by the accompanying diagram, this increase in incorporated material, which averages about 10 per cent for each of the last five years, was chiefly effected in 1899, 1902 and 1903, in which years large accumulations of unmounted, and therefore unrecorded, material were mounted and inserted. This

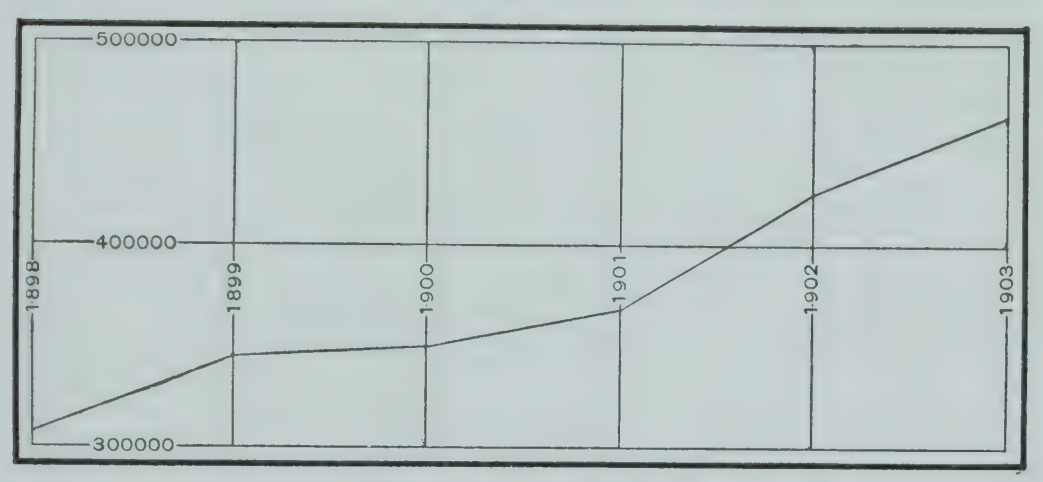
* Rept. Mo. Bot. Gard. **8**: 19.

† Rept. Mo. Bot. Gard. **10**: 18.

MEXICAN HOUSE—Oncidium Luridum.

growth in the herbarium has necessitated the removal of a part of it from the administration building to the old museum, but as this building is of fireproof construction the only resulting disadvantage is somewhat greater difficulty in consulting certain groups in the collection.

DIAGRAM I.




HERBARIUM SPECIMENS.

The herbarium, so far as now mounted, consists of: —

The Engelmann Herbarium (all groups) about . . . 97,859 specimens.
The General Herbarium: —

| | | | |
|---|---|---|---|
| Higher plants. | | | |
| The J. J. Bernhardi Herbarium | 61,338 | | |
| The J. H. Redfield Herbarium | 16,447 | | |
| The Sturtevant and Smith Herbarium . . . . . | 7,446 | | |
| The Gustav Jermy Herbarium . | 4,172 | | |
| The Chapman Herbarium* . . | 3,536 | | |
| Other specimens . . . . . | 237,730 | 330,669 | " |
| Thallophytes. | | | |
| The J. J. Bernhardi Herbarium | 610 | | |
| The Gustav Jermy Herbarium . | 1,659 | | |
| Other specimens . . . . . | 34,408 | 36,677 | " |
| Making a total of . . . . | | 465,205 | " |
| Valued at . . . . . | | | $69,780 75 † |

* So far as yet incorporated.

† This valuation, at the rate of $15.00 per hundred mounted sheets.

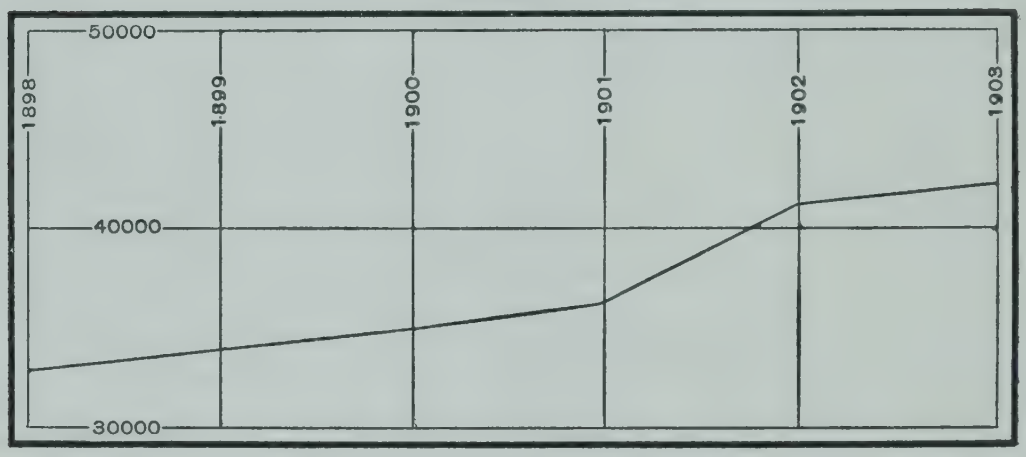
In addition to the herbarium proper, the following material should be noted: —

| | | | |
|---|---|---|---|
| Wood specimens of various sizes . . . . | 1,027 | valued at | $100 00 |
| Wood veneers by Hough and others . . | 2,354 | " " | 165 00 |
| Microscope slides by Penhallow and others | 1,051 | " " | 250 00 |
| Together . . . . . | 4,432 | " " | $515 00 |

## THE LIBRARY.

As in earlier years, a satisfactory growth of the library is to be noted. In 1903, 353 books, valued at $651.40, and 169 pamphlets, valued at $46.45, were presented or re-

DIAGRAM J.



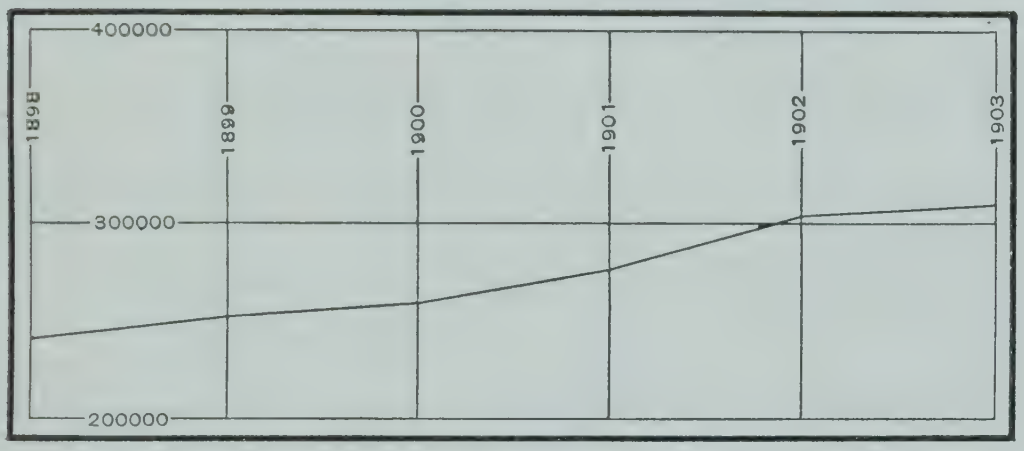

BOOKS AND PAMPHLETS.

ceived in exchange for Garden publications; and 505 books and 11 pamphlets were obtained by purchase. The present total, therefore, is 42,262 books and pamphlets, or an increase of 9,618, or 29.4 per cent, over the 32,643 contained in the library at the end of 1898.* This is an average of about 6 per cent for each of the last five years, the exact distribution of the growth being indicated by the accompanying diagram which shows that the customary growth was experienced in 1903, that for the preceding year having been unusually great.

* Rept. Mo. Bot. Gard. **10**: 19.

Though fewer cards have been written at the Garden than usual, the card index was enlarged in 1903 by the incorporation of 8,263 cards, of which 1,872 were written by employees, 1,067 were presented, and 5,324 were purchased, the expenditure for cards and cases amounting to $46.07. The total is now 311,218, an increase of 66,533 over the number at the end of 1898. This increase, shown on the accompanying diagram, amounts to 27.7 per cent of the number recorded at the end of 1898,* or about 5.5 per cent for each of the last five years.

DIAGRAM K.




INDEX CARDS.

The Secretary's statement shows that in 1903, $3,026 70 was spent for library purchases and binding, — in the latter of which directions unusual progress has been made this year though many of the large sets of serials, which have come to us unbound, are still in this condition. As with the herbarium, the library has so far outgrown its quarters in the administration building as to necessitate the removal of many books to the old museum, but the subject classification adopted on the shelves renders these scarcely less accessible than the others, and they are as safely housed.

* Rept. Mo. Bot. Gard. **10** : 19.

As now constituted, the library contains: —

| | | | | |
|---|---|---|---|---|
| Pamphlets | 22,788 | | | |
| Books | 19,408 | | | |
| | 42,196 | valued at | | $70,430 85 |
| Manuscript volumes | 66 | " | " | 800 00 |
| Total | 42,262 | " | " | $71,230 85 |
| Index cards | 311,218 | " | " | 3,112 18 |
| Total valuation of library | | | | $74,343 03 |

The distinct serial publications now received number 1,185, of which 99 represent subscriptions, and 1,086, issued by 831 institutions or publishers, are received in

DIAGRAM L.

SERIAL PUBLICATIONS.

exchange for the Reports of the Garden. With so large a list of periodicals referring to a limited subject, increase is not rapidly made, but 255, or 27.4 per cent, have been added to the 930 recorded five years ago, — an average of about 5.5 per cent for each of the last five years.

In 1903, 235 copies of the now antiquated little handbook of the Garden were sold, and a large number of copies have been presented to bodies of specially invited visitors, — chiefly representatives of the press.

ORCHID BLOSSOMS—Trichopilia Suavis.

## THE MUSEUM.

As has been reported from year to year, this single part of the plan of Mr. Shaw and of the Board of Trustees has been neglected because of the necessity of using the existing small museum building for other purposes. Whenever it shall be freed from such use, I hope to arrange in the building an instructive and attractive synoptical collection, supplementing those furnished by the living plants of the Garden. In the meantime, considerable reserve research material, not of a character to be publicly displayed, is being received and stored in one way or another, and utilized as occasion offers.

## RESEARCH AND USE OF FACILITIES.

As was contemplated in the first outline of the policy of the Board, quoted above, the principal research work of the Garden has been concentrated on the North American flora, and during the five years just ended, five monographic studies of groups of plants pertaining wholly or in large part to this flora have been published in the Garden Reports. Horticultural botany has likewise received attention, as have the ecology and teratology of plants. For several years the Garden has been made the headquarters for a laboratory directed by Dr. Hermann von Schrenk of the United States Department of Agriculture, in which much useful work has been done on the diseases of cultivated plants, the causes and prevention of decay in timber, and other economic questions of vast material importance, Dr. von Schrenk having provided, among other things, a greenhouse especially devoted to experimental plant growth in these directions.

Provision is now being made for a phyto-chemical laboratory, by the renovation of the basement of the old museum building, which proves well adaptable to this purpose; and

the use of this laboratory, on its completion and equipment, has been placed at the disposal of Mr. J. B. Nagelvoort, an expert plant chemist, who is desirous of devoting the greater part of his time for some years to a study of the active principles of plants, which it is proposed to have cultivated for this purpose under his direction.

In every feasible way the library, herbarium and living collections of the Garden are made useful to investigators, whether connected with the institution or not. When they can be used here, every possible facility for their use is given visiting botanists. When this is not possible, they are sent to trustworthy persons or institutions, when their safe return is guaranteed; and, except for specimens or books of especial value which could not be replaced in case of loss or those in constant use, the Garden has always stood ready to place its library and collections for a reasonable time at the disposal of the botanical departments of colleges, or of capable investigators not having official connection with the centers of learning.

## THE SCHOOL OF BOTANY.

At the end of the last college year, Dr. Hermann von Schrenk, who had been on the instructional force of the School of Botany of Washington University for six years, withdrew to devote his entire time to his important administration and research duties under the Government. His place was taken by Dr. J. A. Harris, who had held the position of Botanical Assistant at the Garden for two years; and Mr. S. M. Coulter, who had been an instructor since the early part of 1901, was promoted to a newly established assistant professorship in the department.

In connection with a newly established department of zoology, an arrangement was this year effected by which Botany 1,* and Zoology 1, of the undergraduate electives,

* Rept. Mo. Bot. Gard. **14**: 24.

each of three weekly periods for a half year, were replaced by a joint course called Biology 1, of five weekly periods for the same time, — the other electives remaining unchanged.

Both beginning and advanced classes in the School of Botany have shown small but gratifying increase in numbers, which it is hoped may be still greater as the University enlarges after removal to its new site. At the last commencement of Washington University, the degree of Master was conferred on Miss Caroline Rumbold and Mr. Perley Spaulding, and that of Doctor, on Mr. J. A. Harris, the major work of all of whom was in botany. At present one candidate for the Master's degree, and three for the Doctor's degree, with botany as a major, are enrolled at the University.

### GARDEN PUPILS.

As has been reported each year, the expressed intention of the founder of the Garden to afford theoretical and practical training in gardening has received earnest care.

In March last, Bruno Nehrling, who had completed the required work and passed a satisfactory examination, was granted the prescribed certificate, and the scholarship so vacated, and one freed by the withdrawal of Oliver Marker, were awarded on the result of competitive examination to Shelby C. Jones of Chicago, and Walter Hummel of Milwaukee. On the nomination of the State Horticultural Society, G. D. Schulte was given a scholarship formerly held on the same nomination by Robert Meyer, resigned; and on the nomination of the St. Louis Florists' Club, Walter Gillies was given a scholarship formerly held on the same nomination by William Polst, resigned. Two pupils are expected to complete their work in March next, and an announcement that the scholarships so vacated will be awarded in the spring on the result of competitive examination, was issued in December.

The course of instruction is indicated in detail on the appended table.

| YEAR. | TERM. | STUDIES. | | | | | PER WEEK. |
|---|---|---|---|---|---|---|---|
| SECOND. | April to June. | Floriculture. 3 exercises weekly. | Economic Entomology. 1 exercise weekly. | | Surveying. 2 exercises weekly. | | 6 |
| | July to Sept. | Floriculture. 3. | Economic Entomology. 2. | Book-Keeping. 1. | | | 6 |
| | Oct. to Dec. | Floriculture. 1. | Economic Entomology. 2. | | Surveying. 1 | Elementary Botany. 3 | 7 |
| | Jan. to Mar. | Floriculture. 1. | Twigs of Woody Plants. 1. | Orchard Culture. 1. | Landscape Gardening 1 | Elementary Botany. 3 | 7 |
| THIRD. | April to June. | Vegetable Gardening 4 | | | Landscape Gardening 1 | Botany of Wild Flowers. 2 | 7 |
| | July to Sept. | | Economic Mycology. 1 | Orchard Culture. 2 | Landscape Gardening 1 | Botany of Garden Flowers. 2 | 6 |
| | Oct. to Dec. | | Economic Mycology. 3 | Garden Accounts. 1 | Botany of Fruits. 2 | | 6 |
| | Jan. to Mar. | | Economic Mycology. 3 | Garden Accounts. 1 | | Botany of House Plants. 2 | 6 |
| FOURTH. | April to June. | Orchard Culture. 1 | Forestry. 1 | Book-Keeping. 1 | Surveying and Drainage. 3 | | 6 |
| | July to Sept. | Small Fruit Culture. 4 | | | Botany of Weeds. 1 | Botany of Vegetables 1 | 6 |
| | Oct. to Dec. | Special Gardening 2 | Forestry. 1 | Vegetable Physiology 2 | | Botany of Woody Plants. 2 | 7 |
| | Jan. to Mar. | Special Gardening 2 | Forestry. 1 | Vegetable Physiology 2 | Botanical Geography 1 | Botany of Ferns. 1 | 7 |

In the five years just closed, seven young men have satisfactorily completed the prescribed course of study

EAST INDIAN HOUSE—Nepenthes.

and have received certificates attesting this fact, and a number of others have taken a part of the work, several of them without the advantage of scholarship grants. Most of these pupils who have completed or largely performed the work offered, have left the Garden for useful positions; and the development of the earlier graduates of the school of gardening gives, each year, increasing and gratifying evidence of Mr. Shaw's wisdom in providing for it.

## THE GARDEN STAFF.

At the beginning of the year, Mr. James Gurney, who for many years before Mr. Shaw's death was his Head Gardener, and had continued in that capacity since the establishment of the Garden on its present basis, retired from active service on account of his advanced age. By action duly sanctioned by the Board, he has been made Head Gardener Emeritus, with merely nominal advisory duties, and has thus been given opportunity to devote to the improvement of decorative plants, the larger part of the time formerly employed in looking after the details of gardening.

On the retirement of Mr. Gurney from active service, the office of Superintendent was created, and Mr. H. C. Irish, who for a number of years has been Horticultural Assistant at the office, was appointed to this new position, with responsibility for the general maintenance of the property in addition to the details of gardening, instruction of pupils, and horticultural research, in all of which he has rendered most efficient service.

In the autumn, Dr. Harris resigned his position as Botanical Assistant, to accept an instructorship in the School of Botany of Washington University, and his place was taken by Mr. Aaron G. Johnson, a student in the South Dakota Agricultural College. Mr. C. E. Hutchings

has resumed his place as stenographer, after an absence of a year and a half. In the library, no changes have been made except that Miss Mary A. Norton withdrew at the beginning of the year, no appointment being as yet made to the vacant position, Miss Eva Perles, as in 1902, continuing to give assistance in checking accessions, indexing illustrations, etc. During the greater part of the year, in addition to the services of an extra mounter, the herbarium has received the care of Miss Florence Thiell, who has been occupied with the incorporation of newly mounted material, etc.

## SPECIAL TESTAMENTARY PROVISIONS.

Three annual events provided for in the will of Mr. Shaw have taken place, as follows: —

The annual flower sermon was preached in Christ Church Cathedral, St. Louis, on the morning of May 14th, by Rev. William A. Guerry, Chaplain of the University of the South.

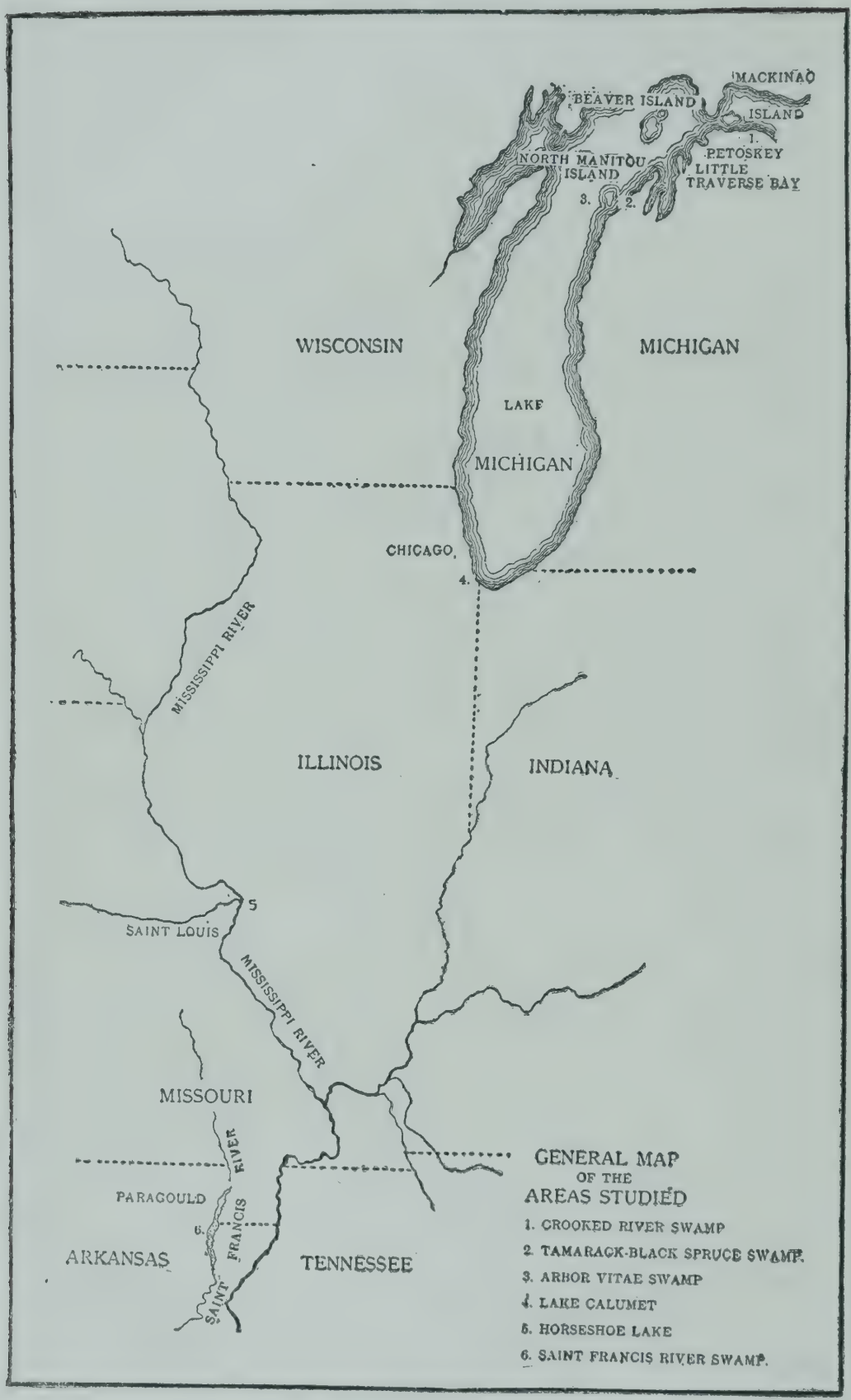
The fourteenth banquet to the Trustees of the Garden and their guests was given at the Southern Hotel, on the evening of January 1st, 1904, having been deferred from the usual time in May, so that gentlemen in attendance on the national scientific meetings, held in St. Louis in Convocation Week, might be invited. About 240 guests, including many distinguished educators and investigators, were present. Speeches appropriate to the occasion were made by President Carroll D. Wright, of the American Association for the Advancement of Science, Hon. David R. Francis, of St. Louis, President David S. Jordan, of the Leland Stanford Junior University, Mr. Smith P. Galt, of St. Louis, Dr. James Fletcher, of the Canadian Central Experimental Farm, the Director of the Garden, and President Henry S. Pritchett, of the Massachusetts Institute of Technology.

The fourteenth banquet to the gardeners of the institution was given at the Mercantile Club on the evening of Friday, December 11, 1903. Seventy-two persons were present, including — in addition to representatives of the Board of Trustees, the office staff, the instructional force of the School of Botany, and investigators working at the Garden — the gardeners and senior garden pupils of the institution, local florists, horticulturists, market gardeners and seedsmen, a number of gentlemen connected with the approaching World's Fair, and the Secretary of the American Pomological Society. After the dinner, an account of the uses being made of horticulture in the broad sense at the Exposition was given by Mr. G. E. Kessler, Landscape Gardener, Dr. Tarleton H. Bean, Chief of the Department of Forestry, Fisheries and Game, and Professor F. W. Taylor, Chief of the Department of Horticulture and Agriculture, of the Exposition, who illustrated their remarks by lantern views showing plans and progress effected. M. J. Vacherot, Architect of the Parks and Gardens of Paris, was the last speaker of the evening.

As in 1902, no flower show was held in the city, so that again no claim has been made for the premiums provided for in the will of the founder of the Garden.

Very respectfully,

William Trelease,
Director.


MACKINAC ISLAND
BEAVER ISLAND
NORTH MANITOU ISLAND
PETOSKEY
LITTLE TRAVERSE BAY
1.
2.
3.
WISCONSIN
MICHIGAN
LAKE MICHIGAN
CHICAGO
4.
MISSISSIPPI RIVER
ILLINOIS
INDIANA
5
SAINT LOUIS
MISSISSIPPI RIVER
MISSOURI
SAINT FRANCIS RIVER
PARAGOULD
6.
ARKANSAS
TENNESSEE
GENERAL MAP OF THE AREAS STUDIED
1. CROOKED RIVER SWAMP
2. TAMARACK-BLACK SPRUCE SWAMP.
3. ARBOR VITAE SWAMP
4. LAKE CALUMET
5. HORSESHOE LAKE
6. SAINT FRANCIS RIVER SWAMP.

SWAMP AREAS

# SCIENTIFIC PAPERS.

## AN ECOLOGICAL COMPARISON OF SOME TYPICAL SWAMP AREAS.*

BY SAMUEL MONDS COULTER.

In the preparation of the present paper the writer has undertaken the presentation of generally known facts regarding the swamp areas investigated, as a foundation for a future working out of the problems there suggested. It is intended to be a collection and grouping together of these data and so may be regarded as a necessary preliminary to such work as may be done hereafter in this field by the writer or by others.

The discussion of the various types of swamp which are here compared must necessarily consist of a description of the present topographical condition of each area, together with a summary of the principal plant forms which characterize it. Hence this paper may be considered as a brief presentation of the similarities and differences between certain swamp areas, expressed in terms of physiography and taxonomy, while the geological history and dynamics of each area are reserved until they can be studied in detail. Numerous interesting problems have presented themselves during the collection of these data and a few of them are mentioned in the paper. It is hoped that some of them may be taken up by others and the results of such investigation added to the too meager working library of the ecologist. The materials for this paper have been gathered during various ecological trips in the last three years, and

* A thesis presented to the Faculty of Washington University, in candidacy for the degree of Ph. D., April, 1903.

the work has been done partly in connection with the Hull Biological Laboratory, University of Chicago, and partly in connection with the Shaw School of Botany, Saint Louis. The author herein acknowledges with gratitude the kindly assistance of his associates in both these laboratories, and, especially, the helpful suggestions of Professor John M. Coulter and Doctor Henry C. Cowles of the University of Chicago, and Professor William Trelease of the Shaw School of Botany. The maps and photographs were made by the author especially for this paper.

## GENERAL VIEW OF THE AREAS STUDIED.

The areas investigated mostly lie along a line about 800 miles long running from near Mackinac Island, Michigan, southwesterly to the vicinity of Paragould, Arkansas, as indicated in the accompanying map. (Frontispiece.)

These studies comprise the following: —

1. A drained swamp along the Crooked River in the northern part of the lower Michigan peninsula.

2. An undrained tamarack-black spruce swamp surrounding a small lake on North Manitou Island, Michigan.

3. A slowly drained arbor-vitae swamp lying along the outlet into Lake Michigan of a larger lake on the same island.

4. The small, swampy lakes south of Chicago: Lake Calumet as a type.

5. Horse-shoe Lake in southwestern Illinois, an old ox-bow cut off from the Mississippi River.

6. A cypress-tupelo gum swamp along the Saint Francis River in northeastern Arkansas.

### 1. RIVER SWAMP ALONG CROOKED RIVER.

At the mouth of the Cheboygan River, near the northern extremity of the lower Michigan peninsula, a dam has been constructed which has considerably enlarged the areas of

a number of connecting lakes above it, and rendered sluggish the current in the small rivers uniting them. A large tract of country is now in a swampy condition on this account, many adjacent forest trees have been drowned out and it is probable that the flora has materially changed from its former condition. A precisely similar tract resulting from a like cause may be observed along Carp Lake in Leelanaw County, Michigan, where the water level has been raised about nine feet by a dam. (Plate 2.) The present flora in these two areas is remarkably similar. The tree zone or part farthest back from the Crooked River channel shows a large number of tamaracks (Larix Americana) probably indicating that the drainage is poor, the back water evidently not changing very rapidly. The arbor-vitae (Thuya occidentalis) and black spruce (Picea nigra) are almost equally prominent with the tamarack, while the white pine (Pinus Strobus), the Norway pine (P. resinosa), the balsam fir (Abies balsamea), the white ash (Fraxinus Americana) and the red maple (Acer rubrum) are the most important secondary trees.

The principal shrubs bordering the channels are the leather leaf (Cassandra calyculata), Potentilla fruticosa, Cornus circinata, C. stolonifera, Alnus incana and Salix glaucophylla. The most prominent herbs in this land margin are the Joe-pye weed and boneset (Eupatorium purpureum and E. perfoliatum), Lobelia cardinalis and L. syphilitica, Impatiens fulva, Polygonum amphibium and Osmunda regalis, the latter fern forming dense fringes overhanging the water's edge. In places where the channel is less defined, the low banks permit the spreading of the water and this land margin gives way to a water margin with a flora varying to meet the changed condition. Here are found great areas of Phragmites communis, Typha latifolia, Scirpus lacustris and Menyanthes trifoliata with Sagittaria variabilis and Iris versicolor in smaller patches. In the open water Nymphaea odorata, Nuphar advena, Pota-

mogeton natans, Vallisneria spiralis, Naias flexilis and species of Ceratophyllum and Myriophyllum are abundant.

The narrower portions of the water way, which extends almost to Petoskey, are kept pretty well cleared of aquatic vegetation by small steamers and lumber rafts. It is likely that the artificial maintenance of the water at near its present level will retard the natural process of filling this area and consequently alter the succession of floral types.

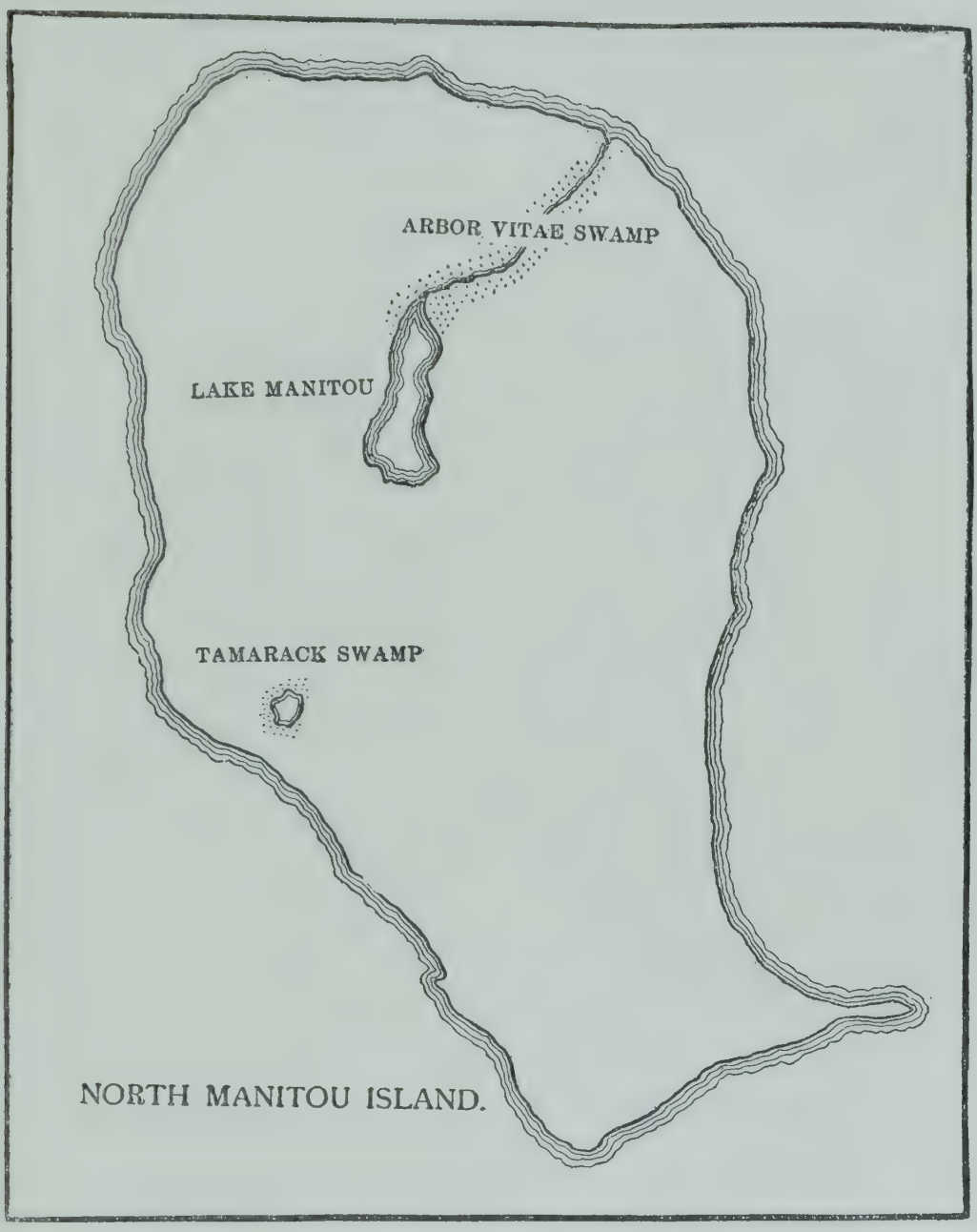
At the outlet of Walloon Lake near Petoskey, the channel is more definite, the stream is more rapid and the flora is more particularly that of a real land margin, the forms being generally such as are found in a very moist woods. The appended list shows the nature of the flora in the Walloon River area.

Acer rubrum.
Aralia nudicaulis.
Aralia racemosa.
Aspidium thelypteris.
Apocynum androsaemifolium.
Bidens connata.
Caltha palustris.
Campanula aparinoides.
Cicuta bulbifera.
Conocephalus conicus.
Dalibarda repens.
Equisetum arvense.
Equisetum limosum.
Galium asprellum.
Galium triflorum.
Gaultheria procumbens.
Gentiana Andrewsii.
Hydrocotyle Americana.
Lathyrus palustris.
Leersia oryzoides.
Lonicera glauca.
Ludwigia palustris.
Lycopus Virginicus.
Mentha Canadensis.
Menyanthes trifoliata.
Myrica Gale.
Plantago major.
Rhus Toxicodendron.
Rosa Carolina.
Rubus triflorus.
Rumex verticillatus.
Salix lucida.
Solanum Dulcamara.
Solidago patula.
Thalictrum purpurascens.
Trientalis Americana.
Ulmus Americana.
Viola blanda.

### 2. UNDRAINED SWAMP.

The undrained tamarack and black spruce swamp is typically represented on the island of North Manitou. Here is a small decadent lake without an outlet which is gradually being filled up by the encroaching vegetation. (Plates 3, 4, and 5.)

The peat mosses which thrive so luxuriantly in poorly drained conditions are among the pioneer forms concerned in this process, while the cranberry (Vaccinium macrocar-




pon) quickly follows and soon forms a foothold for the leather leaf (Cassandra calyculata) and allied forms.

On the land margin the tamaracks and spruces are closely

crowding on the shrubs, and back of these, the hemlock-maple-beech forest is encroaching on the conifers. Whitford * has alluded to the succession of forms in this and similar areas. The flora here is notably peculiar, being decidedly different from any other area on the same island and almost exactly similar to that found in like localities elsewhere in the United States and in Europe. Some of the noticeable features of these swamps are the following: —

1. Large proportion of evergreens, both of the coniferous and broad-leaved types.

2. Pronounced xerophytic flora, *i. e.*, a flora adapted to resist transpiration, the leaves ericoid or pinoid, often vertical, covered with glaucous bloom, rarely pubescent.

3. Prevalence of carnivorous plants, Sarracenia purpurea and Drosera rotundifolia.

4. Abundance of forms bearing fleshy fruits, well adapted to seed dispersal by birds.

The much discussed question as to the prevalence of so-called xerophytic structures in these peat bogs is still an open one. Many suggestions have been made in the attempt to account for the apparent efforts of these swamp plants to protect themselves against loss of water by transpiration, while their environment seems to indicate that their water supply is unfailing and the adaptations for such protection unnecessary. It now seems probable that this "xerophytic" structure is due to some other cause than the mere effort to protect against water loss.

Kihlman † is of the opinion that the xerophytic structure belongs to northern forms which are exposed to strong

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* Whitford, H. N., The Genetic Development of the Forests of Northern Michigan; A study in Physiographic Ecology. (Bot. Gaz. **31**: 313. 1901.)

† Kihlman, Pflanzenbiologische Studien aus Russisch-Lappland. (Acta Soc. pro Fauna et Flora Fennica, **6.** (1890).

winds and the coincident cooling of the earth. Johannsen * holds that these structural conditions are called forth by the reduced absorptive ability of the roots on account of an insufficient oxygen supply. Warming † adds to the above his belief that the xerophytic structure was required because the stomata had lost the power to close themselves. H. Nillson ‡ has arrived at the definite conclusion that the xerophytic structure stands in intimate connection with the paucity of nourishment in the soil.

The zonal distribution of plants is well illustrated in these tamarack swamps. Within the surrounding forest of maple, beech and hemlock, the real swamp area is found. The surface of the peaty soil is covered with Sphagnum and this zone is dominated by Larix Americana and Picea nigra.

Thuya occidentalis is next in importance and Acer rubrum, Betula lutea and Pyrus Americana are among the most noticeable of the remaining trees, though they are only occasionally found. Beginning in this zone and extending to the water's edge is an immense tangle of waist high shrubbery in which the leather leaf is most predominant, closely followed by Kalmia glauca, Vaccinium Canadense, Gaylussacia resinosa, Ilex verticillata, Nemopanthes fascicularis and Pyrus arbutifolia. In more open spots the marsh fern (Aspidium thelypteris) is exceedingly abundant while the Osmundas are equally so in the tree zone. The lake margin is very poorly defined, the shrub zone being more or less predominant in different localities. The most typical forms near the water margin are Potentilla palustris, Menyanthes trifoliata, Dulichium spathaceum, Lysimachia thyrsiflora, Cicuta bulbifera and Scutellaria galericulata, while the creeping snowberry, Chiogenes

* Johannsen, Plante fysioligi. 324.

† Warming, Plantesamfund. 150.

‡ Nillson, H., Einiges uber die Biologie der schwedischen Sumpfpflanzen. (Bot. Cent. 76:9).

serpyllifolia, is found overrunning all the areas described above. Gaultheria procumbens, Sarracenia purpurea and Drosera rotundifolia are likewise common but not confined to any particular zone.

Coming into the open water, Polygonum Hartwrightii, Phragmites communis, Typha latifolia and Nuphar advena complete the list of common and typical forms.

In a peat bog in the vicinity of Mount Katahdin, Maine (Plate 6), the filling up of the depression had progressed farther and there was little open water remaining. Although this area is 2,600 feet above tide water, there is found a considerable similarity between the species represented there and those in the northern Michigan swamp. Larix Americana is very scarce in the Maine region, though the lumbermen say that a number of years ago it was plentiful but was killed off by "borers." In any case the dominant tree now found about this swamp is the black spruce, Picea nigra.

These trees are very small upon the east side, larger on the north, where are found a number of trees of Thuya occidentalis also, and largest upon the west side where Pyrus Americana is associated with the spruce. It is practically the only tree on the south side.

Among the shrubs characterizing the Northern Michigan area, there were found here Cassandra calyculata, Nemopanthes fascicularis, Kalmia glauca and Pyrus arbutifolia. Vaccinium Canadense is found in the neighboring thickets; and in the bog itself are found V. Oxycoccus, V. uliginosum and V. Vitis-Idaea.

The strictly water forms, Potentilla palustris, Menyanthes trifoliata, Polygonum Hartwrightii, Phragmites communis and Typha latifolia were not found in the Maine swamp: as has been already stated there is little open water left. In the wettest places species of Sphagnum, Scheuchzeria palustris, Drosera rotundifolia and Sarracenia purpurea are the typical plants. Osmunda cinnamomea is a character-

istic plant in the shrub zone. The character plants found in the Katahdin region and not in Michigan are Carex miliaris, Eriophorum gracile, Ledum latifolium, Viburnum cassinoides, Smilacina trifolia Empetrum nigrum.

In a small sphagnum bog on Long Island, New York, there was observed a still later condition in which the water was practically all gone, except in small depressions where the Sphagnum is growing luxuriantly. Associated with the Sphagnum or growing in a habitat slightly elevated above it, are Aspidium thelypteris, Onoclea sensibilis, Osmunda cinnamomea, Impatiens fulva, Elodes campanulata, Hydrocotyle Americana, Mimulus ringens, Rhexia Virginica, Eupatorium perfoliatum, E. purpureum, Asclepias incarnata, Rubus hispidus and Alnus serrulata. It will be readily observed that this association suggests a brookside flora rather than that of a sphagnum swamp, and it is probably due to the fact that as the vegetation increased, areas were elevated somewhat and the water was gradually drawn off into small channels, thus giving the area a little better drainage.

The Sphagnum still clings to those depressions where the drainage is slow.

Sarracenia purpurea and Drosera rotundifolia have been reported from this locality, but they could not be found at the time these observations were made. If these forms are disappearing, it would tend to corroborate the above hypothesis. The marginal flora is becoming heath-like, the most characteristic forms being Alnus serrulata, Myrica cerifera, Pinus Strobus saplings, Juniperus Virginiana, Vaccinium Canadense, Chrysanthemum Leucanthemum, Anaphalis margaritacea, Epigaea repens, Polytrichum commune and Cladonia rangiferina.

### 3. SLOWLY DRAINED SWAMP.

A much larger lake than the one described above is found on the same island; its banks are well defined and rarely

marshy with the exception of the northeastern end, where the lower level of the ground has permitted an outlet into Lake Michigan. (Plate 7.) As no large volume of water overflows, it has not succeeded in cutting out a well-defined channel. The rapidly growing vegetation has assisted in the partial damming of this small stream, so that it has gradually spread out until quite a large area is now occupied by its meanderings. The current, although exceedingly sluggish, has a general onward movement, slowly changing the water about the roots of the vegetation. Probably from this cause or one related to it, the vegetation is strikingly different from that in the last described area. The largest tree in this swamp is the white pine (Pinus Strobus), but the dominant one is the arbor-vitae (Thuya occidentalis), here growing to great size, fifty feet in height and twenty inches in diameter. A great many dead and dying trees are found, but whether they have lived out their natural existence or died from lack of sufficient nourishment, it is impossible to say. The fall of these dead trees has been attended by the uplifting of great masses of earth and organic debris which have united to form large hummocks throughout the swamp and the existence of these hummocks has determined the vegetation to a great degree. This great tract of trees and undergrowth amid a mass of fallen logs and brush forms a dense jungle of vegetation which is almost impenetrable.

Next in importance to the arbor-vitae comes the white ash (Fraxinus Americana), the only deciduous tree observed except an occasional yellow birch (Betula lutea) encroaching from the marginal forests. Abies balsamea is frequently found here. In a rather similar area studied on Beaver Island, Mich., the tamarack is quite abundant as is also the paper birch (Betula papyrifera). The principal shrubs occurring near the margin or upon the hummocks are second growth arbor-vitae, Acer Pennsylvanicum and A. spicatum. The yew (Taxus Canadensis), which

is a typical dense shade shrub, is found abundantly. On Beaver Island there are added Salix rostrata, Populus balsamifera and Ledum latifolium. Among the herbs, the shade loving ferns, Osmunda regalis, Botrychium Virginianum and Cystopteris bulbifera are prominent, while in the more open spots where there is abundance of water, Scutellaria lateriflora, Lycopus Virginicus, Impatiens pallida, and Epilobium coloratum are most characteristic. In the Beaver Island area the swamp is much drier and soil herbs are more typical.

Among these Symplocarpus foetidus is very common. The most abundant low herbs in both areas are Linnaea borealis, Dalibarda repens, Viola blanda, Coptis trifolia, Chiogenes serpyllifolia, Clintonia borealis and Galium triflorum. Marchantia and Conocephalus grow abundantly in the wetter places while the mosses luxuriate upon the logs. Hypnum crista-castrensis, Climacium dendroides, Thuidium delicatulum, Dicranum scoparium, Mnium sylvaticum and Sphagnum squarrosum are among the dominant forms. Later stages in the history of the arbor-vitae swamp may be observed in the region about Little Traverse Bay on the main land.

Along the outlet of Roaring Brook, the conditions are mesophytic at present, though the most characteristic plants are still the same as those in the typical area just described. Associated with them, however, are the rapidly encroaching plants one might expect to find in such a mesophytic area, and here may be seen the probable destiny of the arbor-vitae swamp. Notable among these plants are Aralia nudicaulis, Trientalis Americana, Lycopodium lucidulum, Cornus Canadensis, Maianthemum Canadense and Streptopus roseus.

#### 4. THE PRAIRIE SWAMPS ABOUT CHICAGO.

Lake Calumet is one of a series of small lakes which occupy the lower depressions of old Lake Chicago. Other

lakes of this series lie between Lakes Calumet and Michigan, representing various stages in the history of the pond from the open water to the typical prairie or forest. Lake Calumet is three and one-half by one and one-half miles in extent and its drainage is somewhat peculiar. In the southeast corner begins a stream, the first 200 yards of which forms the main stem of a Y. One of the arms of the Y stretches southward forming the Calumet River which, with its tributaries, drains a large section of the surrounding country. The other arm turns north and, after a somewhat tortuous course of six miles, flows into Lake Michigan. At some periods of the year, the current is flowing into Lake Calumet, at other periods it is flowing out. Conditions of rain fall, evaporation and other factors regulate this flow. Lake Calumet is, therefore, simply a bayou of the Calumet River and is subject to an average variation of twenty-two inches in level during the year. The southern end of the lake is thus afforded a considerable amount of drainage and consequent change of water. On the same account the northern end of the lake is subject to a much smaller degree of drainage, and even this small amount is much retarded by the great abundance of vegetation in this part. It is interesting to note in this connection that in the northern end are found such forms as Riccia and Ricciocarpus which are known to thrive well where the drainage is poor. A comparative study of the forms in the northern and southern portions of the lake could well be made with a view to discovering what influence the question of drainage exerted upon their determination. The western shores as well as the northern are exceedingly marshy.

Dense formations of Scirpus lacustris extend for nearly one-half a mile into the lake, scattered patches being found far out from the general mass of vegetation.

Occasional clumps of bulrushes are forming potential islands along the eastern shore and in the northeastern

part an island of considerable dimensions has been formed, composed principally of the remains of former vegetation and now supporting quite a variety of plants. As one comes south along the eastern shore, open stretches of water are found where the usual marginal growth of rushes has been interrupted. This may be related to depth of water, nature of substratum, exposure or manner of propagation. The latter thought suggests the question whether propagation here takes place by rhizomes extending in the soil under the water, or whether the seeds float a while, then sink and germinate. Associated with these open areas, there is found an erosion of the shore until a bluff is formed two or three feet high. This is the natural result of the action of the waves raised by the prevailing west winds upon a shore where there is no protecting fringe of vegetation. Extensive masses of the tubers and rhizomes of Scirpus fluviatilis help to bind together the soil of these exposed bluffs, the slow decay of the wiry rhizomes retarding the erosion to a considerable degree. An interesting point for investigation would be the change of condition which is now causing the erosion of an area which at one time was permitted to be deposited. Many of these old root remains are two feet beneath the surface and must have been in position a long time. The area immediately east of these little bluffs is level and raised only a few feet above the lake. It is occupied by gardens or small farms and the alluvial soil is cultivated to within a few feet of the water, a fringe of tall weeds occupying the edge of the bluff. The same weeds occupy a position corresponding to a similar depth of soil where there is no bluff, but where the protecting vegetation has permitted a marshy soil formation to the lakeward side of the weeds. The dominant forms are Ambrosia trifida, Amarantus retroflexus, Chenopodium album and Melilotus alba. In the open water of the lake there is a great abundance of strictly aquatic vegetation. Among the most important

may be mentioned the Potamogetons, Heteranthera graminea, Pontederia cordata, Brasenia peltata, Elodea Canadensis, Myriophyllum and Ceratophyllum. Cowles* has listed the character plants of this area and discussed its dynamics to some extent. An exhaustive study of the history of this and other areas in the pond-swamp-prairie series would form a valuable addition to ecological literature.

5. HORSE-SHOE LAKE, AN OLD "OX-BOW" OF THE MISSISSIPPI.

In the lowlands of the Mississippi opposite Saint Louis there are many of these depressions which have once been a part of the river bed, but are now cut off by the shifting of the channel. One may find them in every stage of advancement, from the open lake through the marsh to the solid "bottom land." As has been said of the pond-swamp-prairie series, so it may be stated of this region, that a thorough investigation of the conditions at work in filling up these lakes and swamps, and the succession of forms concerned in the process would comprise a welcome contribution to this department of science.

On the northern shore Nelumbo lutea is the prevailing type plant farthest from the shore. An occasional Nymphaea odorata may be observed. (Plate 8.)

Scirpus maritimus is the prominent water margin plant, extending up the marshy shore 40 or 50 feet. This gives the tone to the landscape at this point, but an important, though inconspicuous, plant which borders it lakeward is Jussiaea repens. Associated with the Scirpus maritimus and partially concealed by it is a species of Eleocharis which becomes very vigorous and abundant in places where the taller bulrush is more sparse.

In other places the Eleocharis has been forced more to

* Cowles, H. C. The Plant Societies of Chicago and vicinity. (Bulletin of the Geographic Society of Chicago. 2: 41. 1901.)

the water's edge by the Scirpus. Scirpus lacustris is also present here, but remains secondary in importance to S. maritimus. Sagittaria variabilis follows along the shore in patches. Bidens frondosa begins in this zone but culminates on the shore side. Diminutive forms, Wolffia, Lemna and Spirodela, are found abundantly in this zone. The second zone varies greatly in width and the tension line between it and the first is very irregular.

The Carices are the most abundant forms, but not so conspicuous as some larger plants which are equally common with each other. This association consists of Polygonum Muhlenbergii, Boehmeria cylindrica, Apocynum androsaemifolium, Hibiscus militaris, Amorpha fruticosa and Bidens frondosa. Pilea pumila is very abundant but not conspicuous. Bordering this zone, there is a slight rise of six inches or more which is sufficient to introduce a shrub or tree margin, and along this border line Amsonia Tabernaemontana, Cephalanthus occidentalis and Salix longifolia are prominent. (Plate 9.) In the shrub zone one notes a few climbing forms, Polygonum scandens, Apios tuberosa and Strophostyles palustris. Eupatorium coelestinum is most common, E. altissimum and Erigeron annuus are secondary, while Salix amygdaloides and Betula lutea are the most characteristic shrubs. This zone gradually merges into the real tree zone which occupies the old river shore. Immense sycamores (Platanus occidentalis), swamp maples (Acer rubrum) and cottonwoods (Populus monilifera) are the typical trees. A dense undergrowth of shrubs is found here, the most noticeable of which are Betula lutea, Salix amygdaloides, Forestiera acuminata, Ulmus fulva, Fraxinus Americana, Crataegus viridis, Cornus asperifolia and Gleditsia triacanthos. Sicyos angulata, Vitis cinerea, V. riparia and Tecoma radicans are the prominent lianas. Boehmeria cylindrica, Astragalus Canadensis and Oenothera biennis are common and in small clearings Ambrosia trifida and A. artemisiaefolia have been introduced.

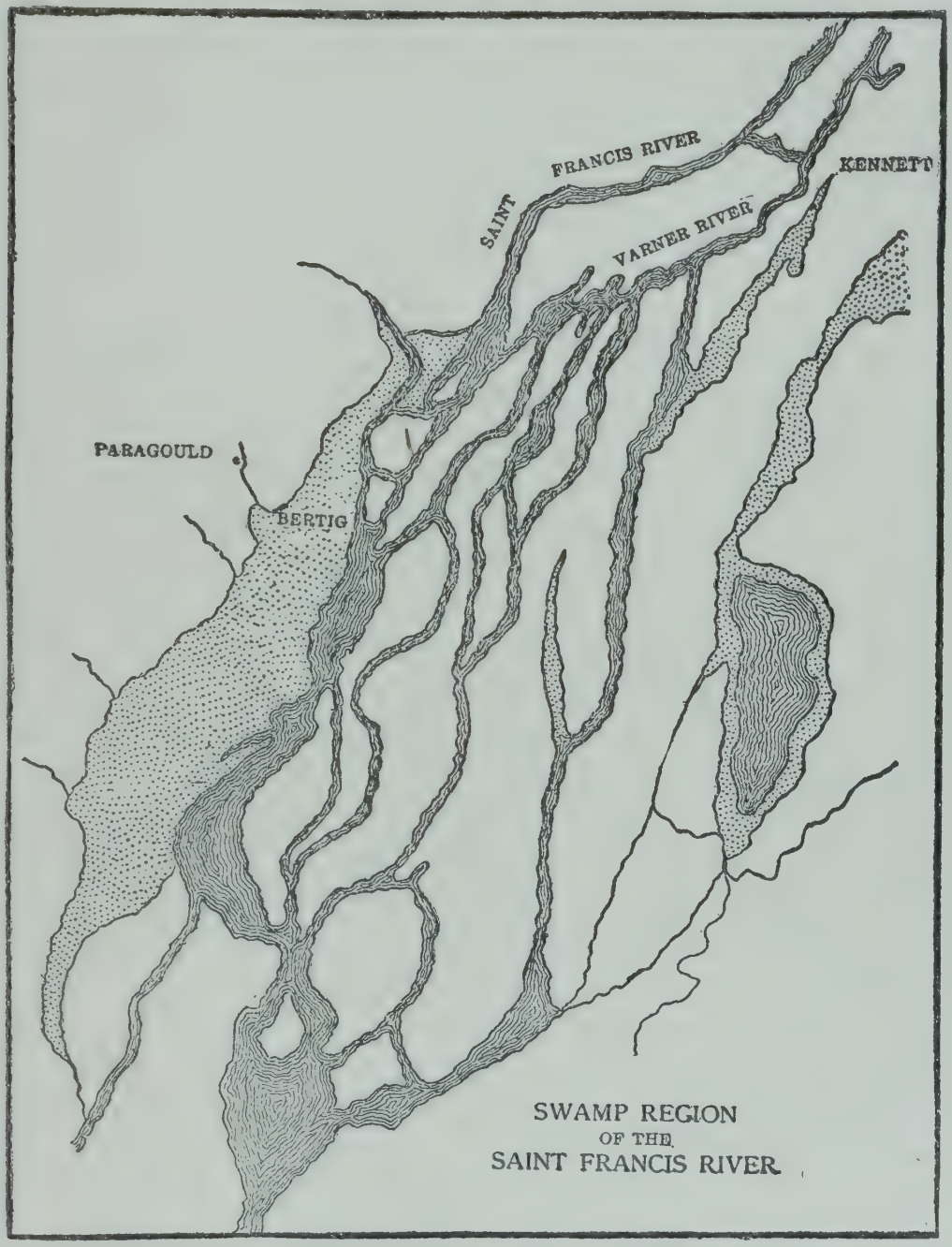
Farther east a small stream enters the lake and along its quiet shore Jussiaea repens forms a conspicuous border. (Plate 9.) Scirpus maritimus is wanting and Polygonum Muhlenbergii and Sium cicutaefolium crowd each other for the next place and then quickly give way to a shrubby thicket of Salix nigra, S. amygdaloides and S. longifolia, which, in turn, are almost entirely succeeded by Forestiera acuminata, a form which seems so well adapted to this habitat, that other forms scarcely exist in the almost impenetrable thicket it makes beyond the willows. There is no ground vegetation whatever and only an occasional willow. An interesting adaptation is shown by the Forestiera which accounts in part for this dense thicket growth. Where the long, drooping branches touch the wet soil, roots are quickly put out and in a short time young and independent trees have originated. (Plate 10.) Somewhat north of this thicket an axe clearing has been made, and here the same willows are beginning to come in.

Typha latifolia is the commonest plant here, Bidens frondosa nearly equaling it. Sagittaria variabilis occupies the moister places, Penthorum sedoides is also frequent and seedlings of Acer dasycarpum are abundant. Bounding the Forestiera thicket and the clearing one finds large trees of Fraxinus Americana and Acer dasycarpum farther back.

### 6. A CYPRESS-TUPELO GUM SWAMP ALONG THE ST. FRANCIS RIVER.

A tract of land lying in Dunklin County, Missouri, and in Greene County, Arkansas, furnishes an excellent area for the study of a semi-southern river swamp. Through this territory runs the Saint Francis River, and it, together with its tributaries, covers wide stretches of the lowlands with a varying depth of water. At some seasons one may pass dry-shod over miles of woodland, which at other seasons is covered with water to a depth of two feet or more. It is this variability in amount of water which ren-

ders the conditions of these swamp lands peculiar, and makes their study particularly interesting. In the vicinity of Bertig, Arkansas, there is an average fluctuation of




about twenty-four inches during the year, though this has been observed to reach as much as forty-four inches. In the spring when the water was some fifteen inches below

its maximum mark, observations were begun. In open spaces where the water is sufficiently quiet, the Polygonum densiflorum seems to be the first in order of succession of those plants which obtain a foothold in the soil and lift themselves out of the water. A large proportion of the river bottom is covered with Myriophyllum, Ceratophyllum, Potamogeton and Cabomba, and this filling up of the channel and consequent slowing down of the current renders it possible for such amphibious plants as Polygonum and Zizaniopsis miliacea, which succeeds it very closely, to secure a foothold. (Plates 11, 12, and 13.)

In a similar locality on the Varner River, near Kennett, Missouri, the Polygonum was found and associated with it Typha latifolia and Peltandra undulata. In many quiet places clear of larger growth, the water is literally covered with Azolla Caroliniana, with a considerable amount of Lemna minor and occasional plants of Ricciocarpus natans. Going shoreward the Polygonum still persists in abundance, Peltandra increases, Saururus cernuus appears and is almost equally represented. Sium cicutaefolium appears in this zone also. A willow undergrowth marks the beginning of what may be considered the next zone, and, quickly following the willows, one notes the Cephalanthus occidentalis which soon becomes conspicuous. Where the underbrush is interrupted, immense areas of Nelumbo are found interspersed with Nuphar advena, the great leaves crowded together in dense masses. In this zone closely following the button bush and willows the tupelo gum (Nyssa uniflora) and the bald cypress (Taxodium distichum) first make their appearance, and the characteristics of these two trees and their relations to the swamp lands are worthy of a thorough investigation.

### *Nyssa uniflora.*

In very early spring when the areas in which the tupelos are growing are flooded, one may find the inch long

fruits floating everywhere, and shortly after the water has subsided, the ground is thickly covered with little seedlings whose continuance depends on their ability to keep their heads above water when it rises. In the latter part of October, they were observed to be about a foot in height and growing vigorously and rapidly. The soil at that time was comparatively dry. Every gradation in size may be observed in the tupelos of these river swamps. In one region they were mere shrubs, not exceeding twenty feet in height. In certain other areas where the Nyssa is entirely dominant, young trees from thirty to fifty feet in height are standing straight and close together, the crown of leaves high up and very few branches below. (Plate 1.) Near the water line occurs the characteristic bulge in the trunk which becomes so pronounced in the older tree. For a considerable space above and below this water line, the trunks in April were covered with a species of Porella which seems to thrive luxuriantly in this habitat. As the tupelos in the swamp grow older, one finds the lower portion of the trunk continuing to increase in diameter and soon forming a dome-shaped base quite different in appearance from the cone-shaped cypress base in a similar habitat. (Plate 18.) This process is accompanied by the dying away of the tops and the decay of all central tissue until the tree consists of a hollow dome with the shaft above usually broken off thirty or forty feet above the ground, a few scattering limbs bearing what scanty foliage remains.

The tissue of the tree is often torn partially from the roots as the base enlarges, and infoldings occur at the ruptured points which become covered with bark. Similar crevices or splits above the roots often appear as the trunk increases in size, and the bark soon covers the edges and extends some distance within the inner surface. At the time the photograph of the large tupelo shown in the upper figure of Plate 19 was made, there was 22 inches of

water upon the ground and the diameter of the base at the water's edge was twelve feet. The same tree was observed in the fall when the ground was dry, and its circumference where the roots entered the ground was 45 feet. The tupelo in the lower figure of Plate 19, measured 55 feet in circumference where the roots entered the ground, and its height was only 45 feet, a considerable portion of the upper part having been broken off. What the advantage accruing to the tupelo from this enlarged base may be is a matter of much speculation; none of the suggestions so far offered have seemed adequate to the writer. It is certain at least, that no physiological cause has yet been assigned. Where the water supply is scanty, the base is only slightly enlarged, and under ordinary conditions the trunk is normal. The Cypress thrives well in similar areas in this region, but in the Kennett district, nearly all the trees are tupelos. The cypresses are old, dying or dead, and few younger ones are coming on to replace them. In such places one notes particularly the great abundance of epiphytic vegetation. Every dying tree, stump, cypress knee, decaying log or floating limb is literally hidden by a rank growth of grasses, sedges, Rosa Carolina, Itea Virginica and many other forms. (Plate 20.) As the tupelo base enlarges, it affords a favorable foothold for the epiphytic fern, Polypodium incanum, which often completely covers it. This fern possesses the characteristic of shriveling and rolling up its coriaceous leaves during dry weather, and quickly spreading them out again, and becoming bright green in rainy weather.

### *Taxodium distichum.*

The habitat of the cypress is quite similar to that of the tupelo; though it seems probable that the cypress is not the equal of the tupelo in the struggle for the occupancy of this territory. The seedlings and young growing trees of the latter are much more numerous than those of the

former tree. The groves of young cypress are not so unmixed in the Bertig region as those of the tupelo. It can be seen from the photographs that a considerable amount of undergrowth accompanies the cypress; it consists of young tupelos, Cephalanthus occidentalis, Mikania scandens, etc.* (Plate 15.)

The young trees early acquire the conical butt and the roots are soon lifted above the surface of the ground or water, forming the conspicuous "knees" of the cypress forest. (Plates 16, 17 and 18.) It is very noticeable in the Bertig region that the young and middle aged trees have the conical base, while the oldest trees have not, although in the latter case the knees are enormously developed. This is not true of the tupelo, as the base continues to increase in size during the life of the tree. The enlargement of the base of the cypress does not seem to be attended by decay and death, as in the tupelo, but this enlargement, as well as the development of the knees, accompanies the growth in swamps. When growing in dry soil, neither phenomenon occurs. If, as currently reported, there has been a general subsidence of these so-called "sunken lands," it may account for the fact that the older cypresses have not the enlarged base, that is, they may have occupied relatively higher and drier ground until they were well grown and not subjected to the conditions which cause the enlargement of base. After subsidence the newer roots might have developed the knees which are now present. When the usual waters have subsided, the writer has observed these upgrowing roots to have attained a hight of eight feet above the surface of the ground. The general impression exists that these are "breathing roots" and serve the purpose of conveying oxygen to the parts submerged in underlying mud.

* However, near the confluence of the Varner and St. Francis Rivers, fifteen miles above Bertig, there are large groves of cypress covering many square miles in which very few other trees are found.

The comparatively smooth bark of the cypress does not furnish so good a foothold for the Porella, Polypodium and other epiphytes as does that of the tupelo, hence there is little epiphytic vegetation upon the living trees.

The changes one notes in ascending the Saint Francis River from Bertig to Kennett, some thirty-five miles, are not so much in the forms present as in the distribution of those forms. There is a gradual narrowing of the area occupied by the Polygonum-Zizaniopsis association and an encroachment upon it of the Taxodium-Nyssa association. While there is a great deal of the tupelo, in pure or mixed groves, distributed all the way up the river to Kennett, it is noticeable that the cypress increases decidedly. The nature of the woods marginal to the Taxodium-Nyssa association is described below.

Wherever the land appears above the water, in small or in large islands, the forms mentioned usually appear upon it. From experiments made with the cypress as illustrated in Plate 16, it is not necessary for it to be surrounded with water in order to grow vigorously. It seems reasonable to suppose that the conditions upon these islands are suitable for the growth of the cypress, and that it would be found there, were it not for the encroachment upon it of the more vigorous broad-leaved forms. As the latter are evidently stronger in the struggle for occupancy of an area possessing the conditions they require, the cypresses are driven off the land where the broad-leaved trees can live, into the water where they cannot follow. This is well illustrated on all the marginal uplands and islands, for example, at Bear Island where the land is occupied with oaks, sweet gum, etc., while the cypress crowds up to them on all sides, the amount of water marking the tension line between the two types.

In open areas in which the soil of the cypress forest is never covered with a great depth of water, but is dry a

good portion of the year, immense thickets of Planera aquatica are formed.

Sometimes these shrubs are small, forming an almost impenetrable thicket, in other places the trees are larger and much farther apart. The downy red maple, Acer Drummondii, is a notable form as one goes from the swamp proper to higher ground. An interesting succession of the varieties of the ash may be observed in the progress from swamp to mesophytic conditions. Common in the swamp is found Fraxinus Americana profunda; on somewhat higher ground, Fraxinus viridis; in mesophytic surroundings, Fraxinus Americana. The largest of the very abundant trees in these marginal forests is the sweet gum (Liquidambar styraciflua), and associated with it, white and red oaks, immense sassafras trees, Quercus Michauxii, Platanus occidentalis, Gymnocladus Canadensis, Celtis Mississippiensis and Nyssa sylvatica. (Plate 20.) Among the shrubs are found Cercis Canadensis, Lindera Benzoin, Cornus paniculata, Asimina triloba, Ulmus alata, Morus rubra, Euonymus Americanus sarmentosus and Aralia spinosa.

Among lianas are Tecoma radicans, Rhus toxicodendron, Bignonia capreolata and Ampelopsis quinquefolia. An interesting southern form found abundantly in these swamp lands is the cork tree (Leitneria Floridana).

Inasmuch as we find here a meeting-point of the southern forms which have followed up the sluggish tributaries of the Mississippi, and the northern forms which are migrating southward, the farther study of this area is likely to prove intensely interesting. The difficulties attending the separation of these floras ecologically and assigning each part its position, on account of climatic, topographic or moisture conditions, are many, and such a discussion will find no place in this paper, which, as stated in the outset, is intended to be a collection of reliable data concerning these swamp areas.

### SWAMPS OF THE BERMUDAS.

The writer has recently had the opportunity of visiting an undrained peat swamp and also a mangrove swamp on the Bermuda Islands and a brief note regarding them may be of interest.

The Devonshire marsh is a large area which gives evidence that it was once a pond, or, at least, contained much more water than it does at present. It is only a marsh land now with a few pools in the depressions. Two species of Sphagnum were found in these pools, also the mermaid weed, (Proserpinaca palustris) and Lemna minor. The water hyacinth and the cat-tail were abundantly represented in the wettest places, while rooted in the mud were Hydrocotyle Asiatica, Herpestis Moniera, Mentha viridis and Dichromena leuocephala. An immense West Indian fern, Acrostichum aureum, here reaches a hight of seven or eight feet. As the ground becomes a little drier, Osmunda regalis and O. cinnamomea become abundant, the latter especially so. In still drier, peaty soil, Pteris aquilina caudata is growing vigorously and becomes much taller than one's head. The Bermuda cedar (Juniperus Bermudiana), the Palmetto (Sabal Blackburniana) and the dog-bush (Baccharis heterophylla), are the most prominent woody forms. (Plates 21 and 22.) In the driest and most exposed places, the ground is covered with Cladonia and Leucobryum. The resemblance to our own drier Sphagnum swamps is apparent. Sphagnum, royal and cinnamon ferns, cat-tails, brake-fern, reindeer lichen and Leucobryum are all characteristic. The tamaracks or spruces are replaced by the cedar, our local shrubs by those of Bermuda.

A second type is shown by the mangrove swamp at Hungry Bay. (Plates 23 and 24.) This swamp is connected with the ocean and there is a tidal fluctuation of two or three feet. The lower depressions over an area of

several acres are crowded with a dense growth of mangroves fifteen or twenty feet in height.

The general characteristics of the mangrove, Rhizophora Mangle, may be briefly stated.

From the main axis, numerous curving prop-roots are sent down into the mud, giving the tree the appearance of an inverted candelabrum. (Plate 22.)

As these prop-roots branch repeatedly, they soon make an impenetrable tangle of the mangrove swamp. In addition to this, the horizontal limbs send down perpendicular aerial roots which usually branch before entering the water or mud.

The diameter of these roots is approximately the same near the tip as at the point of insertion. The seeds send out pointed radicles while on the tree. When mature they drop to the ground and the pointed end sticks into the soft mud, holding the body erect. It continues growing, the lower end soon becomes rooted in the earth, while the upper end develops a pair of leaves. The mud under the trees is usually covered with these vigorously growing seedlings.

Associated with the true mangrove, there is usually found the false mangrove, Avicennia nitida, which affects a similar habitat. So far as the writer has observed, the latter never sends out aerial roots, though an interesting phenomenon was noticed upon a group of old trees growing in the edge of Walsingham Bay. From the main axis and large branches near the first fork, there were developed numerous short processes, similar to aerial roots except that they were only a few inches long and in clusters. (Plate 24.)

Avicennia nitida possesses one characteristic not shared with Rhizophora so far as observed, viz., it sends up from the roots perpendicular processes to the hight of several inches. These are crowded about the area subtended by

the roots and rise to the surface of the water or slightly above. They are usually less than an inch in diameter and do not taper, so that, in appearance, they resemble somewhat the aerial roots of Rhizophora.

It may be that their function is the same as that of the cypress knees. Besides the seedlings of the mangroves, there may be found along the edge of the water, Salicornia fruticosa, Statice Lefroyi, Sesuvium portulacastrum and Heliotropium curassavicum. Beyond tidewater Conocarpus erectus, the sea mulberry, is abundant. Coccoloba uvifera, the sea-side grape, a large tree with broad glossy leaves and grape-like bunches of fruit, is also a common marginal form. Then appear Borrichia arborescens, Solidago sempervirens, Lantana odorata and Lantana Camara, forming the so-called Bermuda sage-brush. The cedar follows and the vegetation rapidly becomes that found on all the hillsides.

The accompanying table will serve to give a graphic view of the distribution of the characteristic plant forms mentioned in the body of the paper.

| Comparative Table of Species. | Crooked River. | Walloon River. | Sphagnum swamp N. Manitou. | Sphagnum swamp Mt. Katahdin. | Sphagnum swamp Long Island. | Arbor-vitae swa'p N. Manitou. | Arbor-vitae swa'p Roaring Brook. | Lake Calumet. | Horse-shoe Lake. | St. Francis River. |
|---|---|---|---|---|---|---|---|---|---|---|
| Abies balsamea | — | | | | | — | | | | |
| Acer dasycarpum | | | | | | | | | | |
| Acer Pennsylvanicum | | | | | | — | | | — | |
| Acer rubrum | — | | — | | | | | | — | |
| Acer Drummondii | | | | | | | | | | — |
| Acer spicatum | | | | | | — | | | | |
| Alnus incana | — | | | | | | | | | |
| Alnus serrulata | | | | | — | | | | | |
| Amarantus retroflexus | | | | | | | | — | | |
| Ambrosia artemisiafolia | | | | | | | | | — | |
| Ambrosia trifida | | | | | | | | — | — | |
| Amorpha fruticosa | | | | | | | | | — | |
| Ampelopsis quinquefolia | | | | | | | | | — | — |
| Amsonia Tabernaemontana | | | | | | | | | — | |
| Apios tuberosa | | | | | | | | | — | |
| Apocynum androsaemifolium | | — | | | | | | | — | |
| Aralia nudicaulis | | — | | | | | | | | |
| Aralia racemosa | | — | | | | | | | | |
| Aralia spinosa | | | | | | | | | | |
| Asclepias incarnata | | | | | — | | | | | — |
| Asimina triloba | | | | | | | | | | — |
| Aspidium thelypteris | | — | — | | — | | | | | |
| Astragalus Canadensis | | | | | | | | | — | |
| Azolla Caroliniana | | | | | | | | | | — |
| Betula lutea | | | — | | | — | | | — | |
| Betula papyrifera | | | | | | — | | | | |
| Bidens chrysanthemoides | | | | | | | | | | — |
| Bidens connata | | — | | | | | | | | |
| Bidens frondosa | | | | | | | | | — | |
| Bignonia Capreolata | | | | | | | | | — | — |
| Boehmeria cylindrica | | | | | | | | | — | |
| Botrychium ternatum | | | | | | | | | | — |
| Botrychium Virginianam | | | | | | | — | | | |
| Brasenia peltata | | | | | | | | — | | |
| Cabomba Caroliniana | | | | | | | | | | — |
| Caltha palustris | | — | | | | | | | | |
| Campanula aparinoides | | — | | | | | | | | |
| Carex millaris | | | | — | | | | | | |
| Cassandra calyculata | — | | — | — | | | | | | |
| Celtis Mississippiensis | | | | | | | | | — | — |
| Cephalanthus occidentalis | | | | | | | | | — | — |
| Ceratophyllum demersum | — | | | | | | | | — | — |
| Cercis Canadensis | | | | | | | | | | |
| Chenopodium album | | | | | | | | — | | |
| Chiogenes serpyllifolia | | | — | | | — | | | | |
| Climacium dendroides | | | | | | — | | | | |

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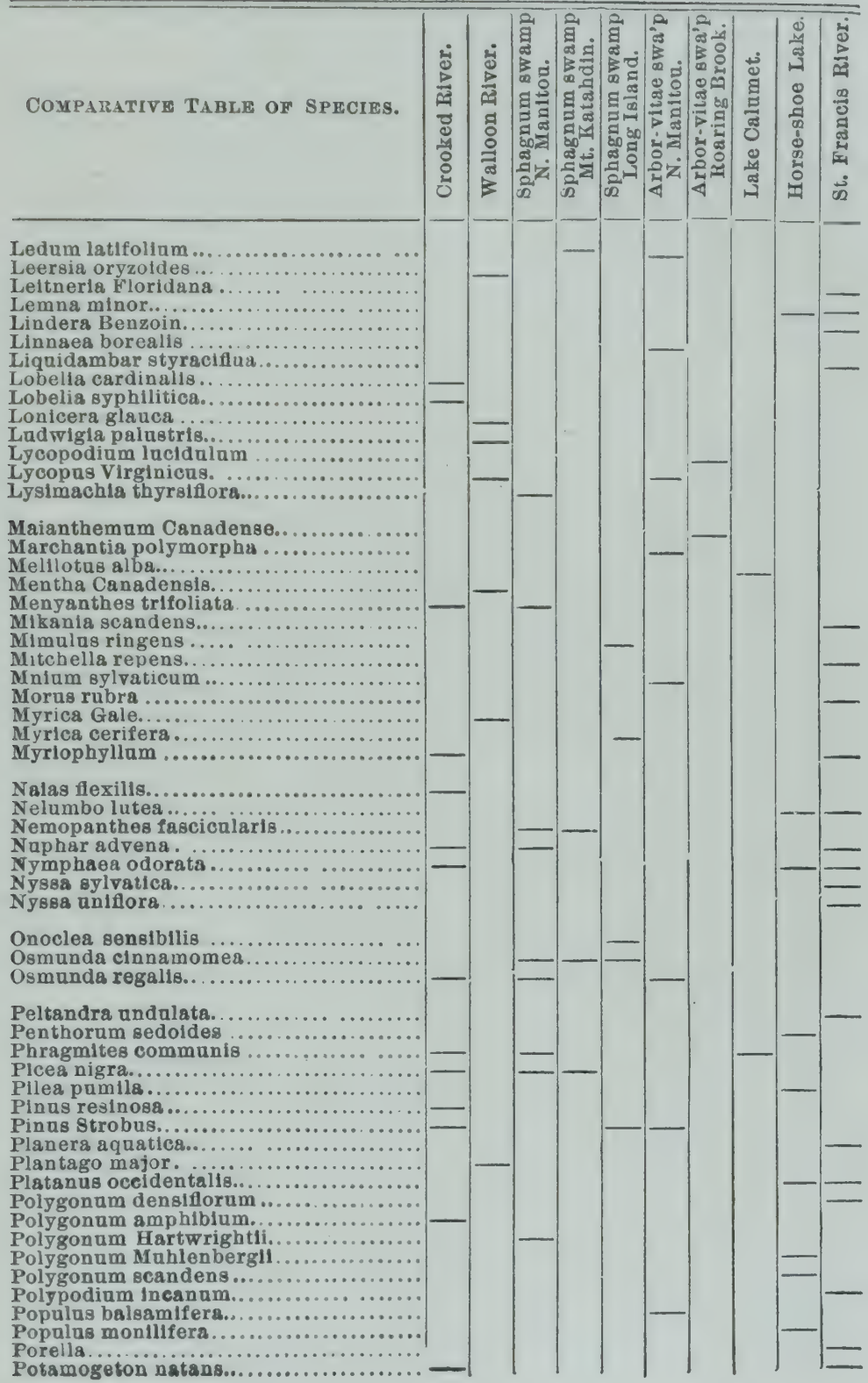
|---|---|---|---|---|---|---|---|---|---|---|
| Cicuta bulbifera | | | | | | | | | | |
| Clintonia borealis | | | | | | | | | | |
| Conocephalus conicus | | | | | | | | | | |
| Coptis trifolia | | | | | | | | | | |
| Cornus asperifolia | | | | | | | | | | |
| Cornus Canadensis | | | | | | | | | | |
| Cornus circinata | | | | | | | | | | |
| Cornus paniculata | | | | | | | | | | |
| Cornus stolonifera | | | | | | | | | | |
| Crataegus viridis | | | | | | | | | | |
| Cystopteris bulbifera | | | | | | | | | | |
| Dalibarda repens | | | | | | | | | | |
| Dicranum scoparium | | | | | | | | | | |
| Drosera rotundifolia | | | | | | | | | | |
| Dulichium spathaceum | | | | | | | | | | |
| Eleocharis | | | | | | | | | | |
| Elodea canadensis | | | | | | | | | | |
| Empetrum nigrum | | | | | | | | | | |
| Epilobium coloratum | | | | | | | | | | |
| Equisetum arvense | | | | | | | | | | |
| Equisetum limosum | | | | | | | | | | |
| Erigeron annuus | | | | | | | | | | |
| Eriophorum gracile | | | | | | | | | | |
| Euonymus Americanus sarmentosus | | | | | | | | | | |
| Eupatorium altissimum | | | | | | | | | | |
| Eupatorium coelestinum | | | | | | | | | | |
| Eupatorium perfoliatum | | | | | | | | | | |
| Eupatorium purpureum | | | | | | | | | | |
| Forestiera acuminata | | | | | | | | | | |
| Fraxinus Americana | | | | | | | | | | |
| Fraxinus Americana profunda | | | | | | | | | | |
| Fraxinus viridis | | | | | | | | | | |
| Galium asprellum | | | | | | | | | | |
| Galium triflorum | | | | | | | | | | |
| Gaultheria procumbens | | | | | | | | | | |
| Gaylussacia resinosa | | | | | | | | | | |
| Gleditsia triacanthos | | | | | | | | | | |
| Gentiana Andrewsii | | | | | | | | | | |
| Gymnocladus Canadensis | | | | | | | | | | |
| Heteranthera graminea | | | | | | | | | | |
| Hibiscus militaris | | | | | | | | | | |
| Hydrocotyle Americana | | | | | | | | | | |
| Hypnum crista-castrensis | | | | | | | | | | |
| Ilex verticillata | | | | | | | | | | |
| Impatiens fulva | | | | | | | | | | |
| Impatiens pallida | | | | | | | | | | |
| Iris versicolor | | | | | | | | | | |
| Itea Virginica | | | | | | | | | | |
| Jussiaea repens | | | | | | | | | | |
| Kalmia glauca | | | | | | | | | | |
| Larix Americana | | | | | | | | | | |
| Lathyrus palustris | | | | | | | | | | |


Comparative Table of Species.
Crooked River.
Walloon River.
Sphagnum swamp N. Manitou.
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Arbor-vitae swa'p N. Manitou.
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Lake Calumet.
Horse-shoe Lake.
St. Francis River.
Ledum latifolium
Leersia oryzoides
Leitneria Floridana
Lemna minor
Lindera Benzoin
Linnaea borealis
Liquidambar styraciflua
Lobelia cardinalis
Lobelia syphilitica
Lonicera glauca
Ludwigia palustris
Lycopodium lucidulum
Lycopus Virginicus.
Lysimachia thyrsiflora
Maianthemum Canadense
Marchantia polymorpha
Melilotus alba
Mentha Canadensis
Menyanthes trifoliata
Mikania scandens
Mimulus ringens
Mitchella repens
Mnium sylvaticum
Morus rubra
Myrica Gale
Myrica cerifera
Myriophyllum
Naias flexilis
Nelumbo lutea
Nemopanthes fascicularis
Nuphar advena
Nymphaea odorata
Nyssa sylvatica
Nyssa uniflora
Onoclea sensibilis
Osmunda cinnamomea
Osmunda regalis
Peltandra undulata
Penthorum sedoides
Phragmites communis
Picea nigra
Pilea pumila
Pinus resinosa
Pinus Strobus
Planera aquatica
Plantago major
Platanus occidentalis
Polygonum densiflorum
Polygonum amphibium
Polygonum Hartwrightii
Polygonum Muhlenbergii
Polygonum scandens
Polypodium incanum
Populus balsamifera
Populus monilifera
Porella
Potamogeton natans

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|---|---|---|---|---|---|---|---|---|---|---|
| Potentilla fruticosa | — | | — | | | | | | | |
| Potentilla palustris | | | — | — | | | | | | |
| Pontederia cordata | | | | | | | | | | |
| Pyrus Americana | | | — | — | | | | — | | |
| Pyrus arbutifolia | | | — | — | | | | | | |
| Quercus Michauxii | | | | | | | | | | — |
| Rhexia Virginica | | | | | — | | | | | |
| Rhus Toxicodendron | | — | | | | | | | | — |
| Ricciocarpus natans | | | | | | | | | | — |
| Rosa Carolina | | — | | | | | | — | | — |
| Rubus triflorus | | — | | | | | | | | — |
| Rubus hispidus | | — | | | — | | | | | |
| Rumex verticillatus | | — | | | | | | | | |
| Sagittaria variabilis | — | | | | | | | | — | |
| Salix amygdaloides | | | | | | | | | — | |
| Salix glaucophylla | — | | | | | | | | — | |
| Salix longifolia | | | | | | | | | — | |
| Salix lucida | | — | | | | | | | | |
| Salix nigra | | | | | | | | | — | |
| Salix rostrata | | | | | | | | | — | |
| Sarracenia purpurea | | | — | — | | — | | | | |
| Sassafras officinale | | | | | | | | | | |
| Saururus cernuus | | | | | | | | | | — |
| Scheuchzeria palustris | | | | — | | | | | | — |
| Scirpus fluviatilis | | | | | | | | — | | |
| Scirpus lacustris | — | | | | | | | — | — | |
| Scirpus maritimus | | | | | | | | | — | |
| Scutellaria galericulata | | | — | | | | | | | |
| Scutellaria lateriflora | | | | | | — | | | | |
| Sicyos angulata | | | | | | | | | — | |
| Sium cicutaefolium | | | | | | | | | — | — |
| Smilacina trifolia | | | | — | | | | | | |
| Solanum Dulcamara | | — | | | | | | | | |
| Solidago patula | | — | | | | | | | | |
| Sphagnum squarrosum | | | — | — | — | | | | | |
| Spirodela polyrrhiza | | | | | | | | | — | — |
| Streptopus roseus | | | | | | | — | | | |
| Strophostyles palustris | | | | | | | | | — | |
| Symplocarpus foetidus | | | | | | — | | | | |
| Taxodium distichum | | | | | | | | | | — |
| Taxus Canadensis | | | | | | — | — | | | |
| Tecoma radicans | | | | | | | | | | |
| Thalictrum purpurascens | | — | | | | | | | — | |
| Thuidium delicatulum | | | | | | | | | | |
| Thuya occidentalis | — | | — | — | — | — | — | | | |
| Trientalis Americana | | — | | | | | — | | | |
| Typha latifolia | — | | — | | | | | | — | — |
| Ulmus alata | | | | | | | | | | — |
| Ulmus Americana | | — | | | | | | | | |
| Ulmus fulva | | | | | | | | | — | |
| Vaccinium Canadense | | | — | — | — | | | | | |
| Vaccinium macrocarpon | | | — | | | | | | | |
| Vaccinium Oxycoccus | | | | — | | | | | | |
| Vaccinium uliginosum | | | | — | | | | | | |
| Vaccinium Vitis-Idaea | | | | — | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|
| Vallisneria spiralis | — | | | | | | | | | |
| Viburnum cassinoides | | | | — | | | | | | |
| Viola blanda | | — | | | | — | | | | |
| Vitis cinerea | | | | | | | | | — | |
| Vitis riparia | | | | | | | | | — | |
| Wolffia Columbiana | | | | | | | | | — | |
| Zizaniopsis miliacea | | | | | | | | | | — |

## EXPLANATION OF PLATES.

Plate 1. — Group of young tupelo, *Nyssa uniflora*, growing in the water and showing beginning of base enlargement. *Porella* growing on the trunks near water line. — Saint Francis River, Arkansas.

Plate 2. — Large tract of *Thuya occidentalis* killed by rise of water occasioned by construction of a dam. — Carp Lake, Michigan.

Plate 3. — 1, *Nuphar advena*, *Menyanthes trifoliata* and *Typha latifolia* in a small decadent lake, rapidly passing into a tamarack swamp. — North Manitou Island, Michigan. 2, Buck-bean zone, *Menyanthes trifoliata*, bordering small lake passing into tamarack swamp. — North Manitou Island, Michigan.

Plate 4. — 1, Border of tamarack swamp on North Manitou Island, *Phragmites communis*, *Typha latifolia* and *Menyanthes trifoliata* in the foreground, *Larix Americana* and *Picea nigra* in the background. 2, Tension line between land and water margins of small lake on North Manitou Island.

Plate 5. — Shrub and tree zones on margin of Sphagnum swamp; *Cassandra calyculata* in the foreground, *Larix Americana* and *Picea nigra* in the background.

Plate 6. — 1, A mountain peat bog surrounded by black spruce; other character plants are *Cassandra calyculata*, *Nemopanthes fascicularis*, *Kalmia glauca*, *Vaccinium Oxycoccus*, *V. uliginosum*, *V. Vitis-Idaea*, *Sphagnum* species, *Scheuchzeria palustris*, *Drosera rotundifolia* and *Sarracenia purpurea*. — Mount Katahdin, Maine. 2, Portion of same bog showing *Sphagnum*, *Drosera*, *Carex miliaris* and *Eriophorum gracile*.

Plate 7. — 1, Beginning of arbor-vitae swamp along outlet of lake on North Manitou Island. — 2, Interior of same swamp.

Plate 8. — 1, Lake margin zone of *Jussiaea repens* bordered with zone of *Scirpus maritimus*. — Horse Shoe Lake, Illinois. 2, Succession of

plant forms along the margin of an ox-bow lake; *Nelumbo lutea, Jussiaea repens, Scirpus maritimus, Salix nigra* and *S. amygdaloides*. — Horse-Shoe Lake.

Plate 9. — 1, Zone of *Scirpus maritimus* with *Polygonum Muhlenbergii* behind it, *Populus monilifera* and *Salix nigra* on the left, *Betula lutea* in the center, and *Salix amygdaloides* on the right. — Horse-Shoe Lake. 2, Margin of small stream which enters Horse-Shoe Lake. In the foreground is *Jussiaea repens*, in the middle ground, *Polygonum Muhlenbergii* and *Sium cicutaefolium*, and in the background a thicket of *Salix nigra, S. amygdaloides* and *S. longifolia* which merges into a dense thicket of *Forestiera acuminata*, the interior of which is shown in the next figure.

Plate 10. — 1, Thicket of *Forestiera acuminata* which spreads rapidly by vegetative propagation. Large tree in the foreground is *Salix nigra*. 2, *Forestiera acuminata*, showing common method of vegetative propagation. — Margin of Canteen Creek, near Horse-Shoe Lake.

Plate 11. — 1, Willow swamp along Canteen Creek, with *Forestiera acuminata, Cephalanthus occidentalis, Polygonum Muhlenbergii, Mentha piperita* and *Sagittaria variabilis*. 2, *Polygonum-Zizaniopsis* association in the St. Francis River, near Bertig, Arkansas.

Plate 12.— 1, Open water zone, Varner River, bordered by growth of *Nuphar advena* and *Azolla Caroliniana*. — Near Kennett, Missouri. 2. General view of cypress swamp in the Saint Francis River, near Kennett, Missouri.

Plate 13.— 1, Channel of Varner River bordered by growth of *Polygonum densiflorum*. 2, *Nuphar advena, Nymphaea odorata* and *Nelumbo lutea*, along the Varner River.

Plate 14.— 1, *Polygonum densiflorum, Typha latifolia, Saururus cernuus* and *Peltandra undulata*, cypress, button-bush and willow undergrowth.— Varner River, near Kennett, Missouri. 2, Mixed cypress and tupelo forest along the Saint Francis River: *Nuphar advena* and *Azolla Caroliniana* in the foreground.

Plate 15.— Group of young cypress trees, *Taxodium distichum*, growing in the water and showing enlarged base.

Plate 16.— 1, Medium sized cypress with group of "knees" projecting nearly four feet above the water which is 30 inches deep at this point. 2, Group of cypress trees in mesophytic condition; no knees or enlarged base.

Plate 17. — 1, Large cypress trees, 6 feet in diameter, surrounded by knees; the bases of these trees not enlarged. 2, Cypress with much enlarged base, surrounded by great number of knees, some of which are eight feet in height. — Margin of Saint Francis River, when usual waters have subsided.

Plate 18, — 1, Large cypress surrounded by knees. 2, Group of large tupelo, *Nyssa uniflora*, showing characteristic enlargement of base. The surrounding undergrowth consists of tupelo, button-bush, *Aralia spinosa* and *Mikania scandens*.

Plate 19. — 1, Tupelo showing enlarged base covered with *Polypodium incanum*. 2, Tupelo showing hollow base and general appearance at time of low water.

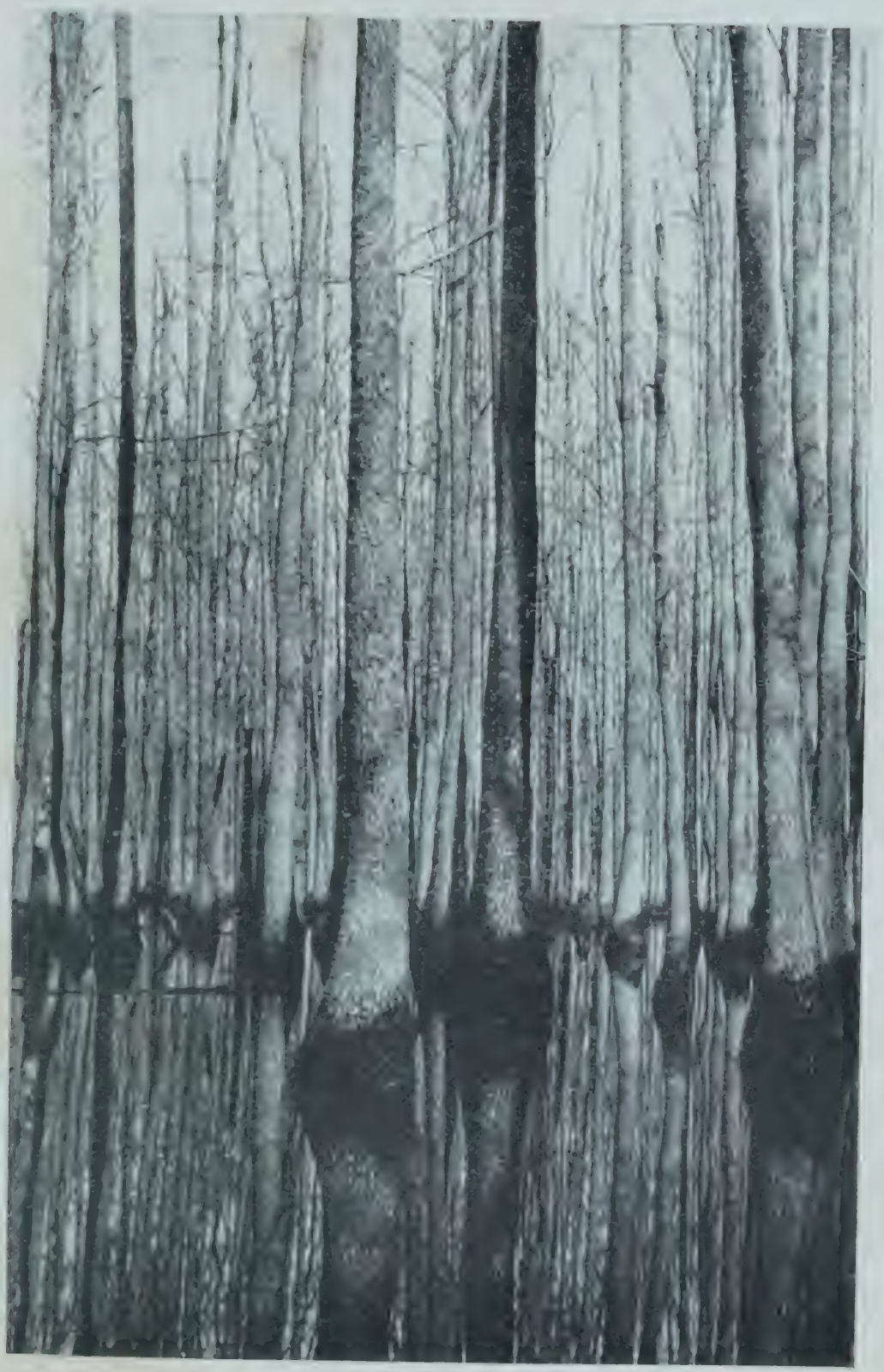
Plate 20. — 1, Along the Varner River: epiphytic vegetation consisting of grasses, sedges, *Rosa Carolina*, *Itea Virginica*, etc. 2, Marginal woods, along the Varner River: *Liquidambar styraciflua*, *Acer Drummondii*, *Sassafras officinale*, *Taxodium distichum*, *Cercis Canadensis*, *Lindera Benzoin*, *Ampelopsis quinquefolia*.

Plate 21. — Oleander, Cedar and Palmetto along margin of peat marsh, *Baccharis heterophylla*, dog-bush, in the foreground. — Bermuda Islands.

Plate 22. — 1, Cedar growing on margin of peat marsh, *Pteris* in the foreground. — Bermuda Islands. 2, Mangroves in Hungry Bay, Bermuda, showing branched prop-roots.

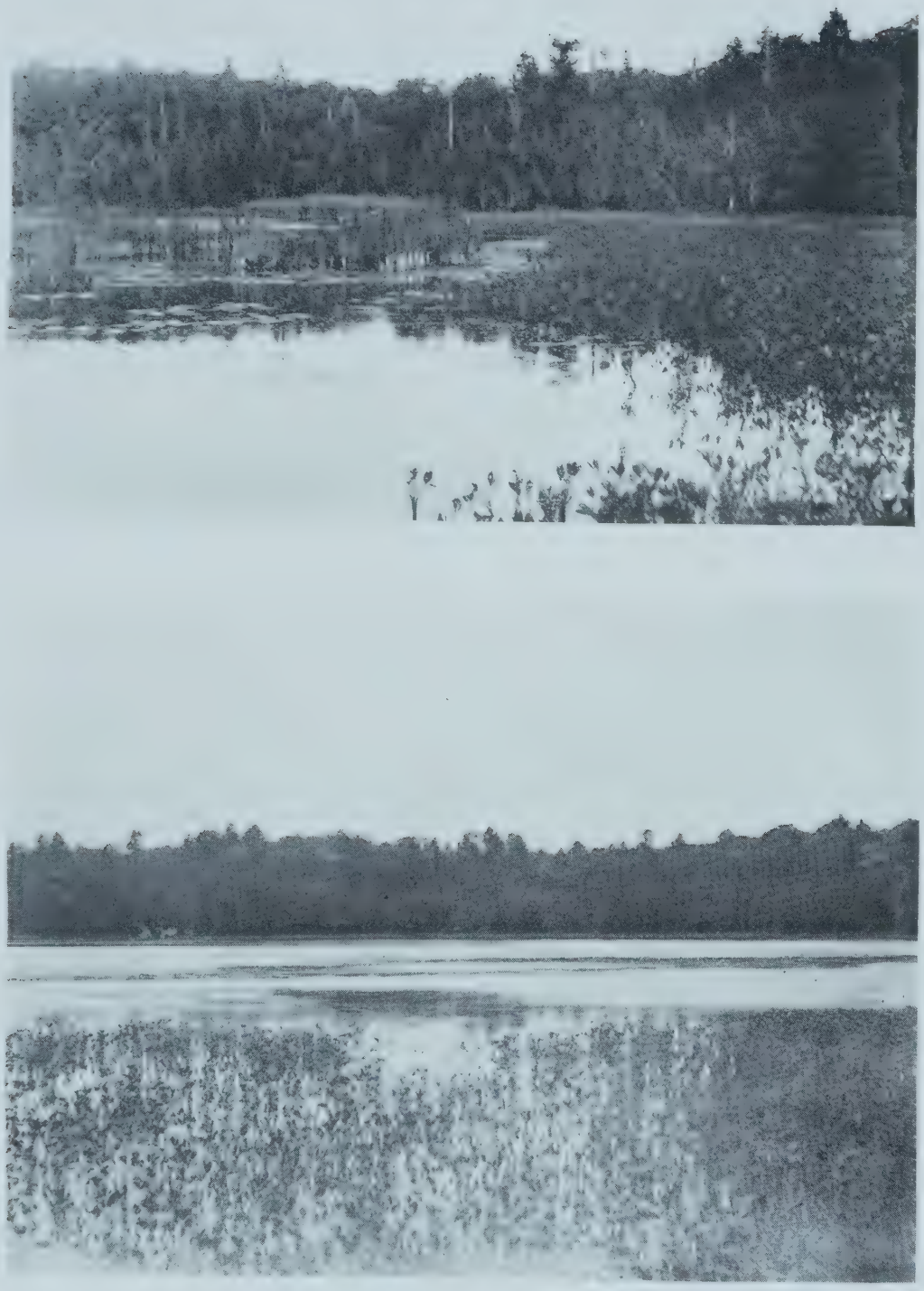
Plate 23. — *Rhizophora Mangle*, the mangrove, showing seeds developing on the tree and young seedlings in various stages of development.

Plate 24. — 1, General view of the margin of a mangrove swamp, showing the prop and aerial roots. 2, *Avicennia nitida*, the false mangrove, showing root-like processes at the fork, and upward growing processes from the roots.



NYSSA UNIFLORA.

THUYA KILLED BY WATER.



NORTH MANITOU ISLAND SWAMPS.

NORTH MANITOU ISLAND SWAMPS

MARGIN OF SPHAGNUM SWAMP.

MOUNT KATAHDIN BOG.

ARBOR-VITÆ SWAMP.

HORSESHOE LAKE SWAMP.

HORSESHOE LAKE SWAMP.

FORESTIERA ACUMINATA.

SOUTHERN SWAMPS.

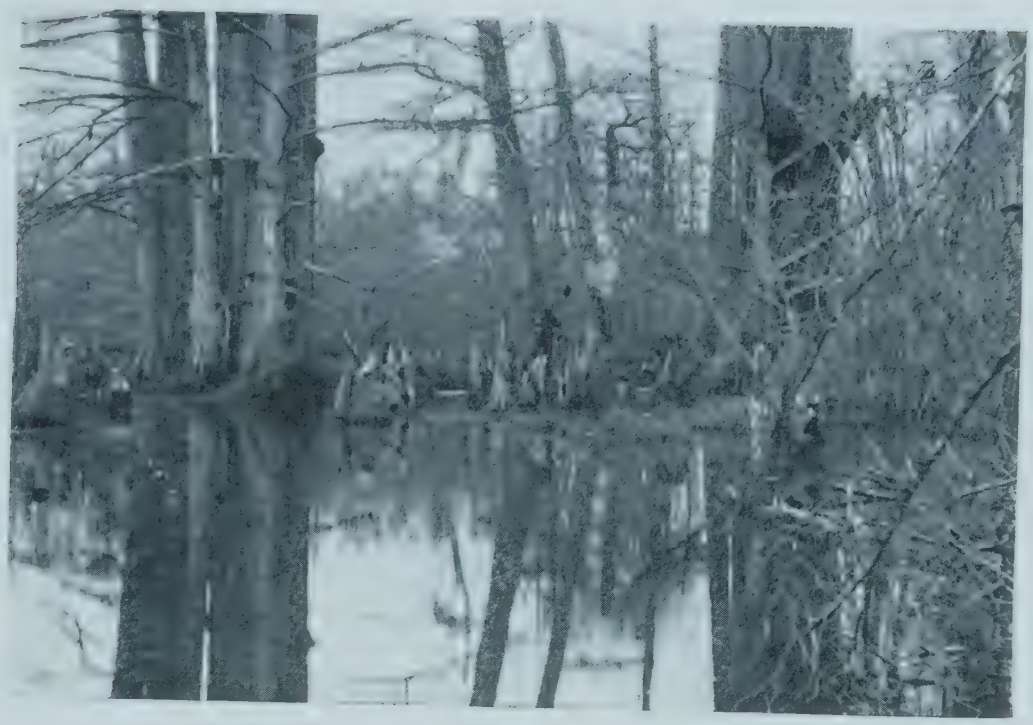
CYPRESS SWAMPS.

SOUTHERN MISSOURI SWAMPS.

SOUTHERN MISSOURI SWAMPS.

TAXODIUM DISTICHUM.

TAXODIUM DISTICHUM.



TAXODIUM DISTICHUM.

TAXODIUM AND NYSSA.

NYSSA UNIFLORA.

SOUTHERN SWAMP MARGINS.

BERMUDA MARSH.

BERMUDA MARSH.

RHIZOPHORA MANGLE.

MANGROVE SWAMP, BERMUDA.

## TWO FUNGI GROWING IN HOLES MADE BY WOOD-BORING INSECTS.

BY PERLEY SPAULDING.

The relation existing between some of the fungi and the wood-boring insects is as yet but little understood and its significance is generally thought to be of slight importance. There are, however, strong and ever-increasing indications that its solution will form one of the most interesting chapters in the history of vegetable pathology, while the economic importance may prove to be much greater than is suspected at the present time.

The curious habitat of two of the fleshy fungi as observed in the southern pine district of eastern Texas has been very interesting to the writer because of the influence which insects were seen to exert upon the distribution of the fungi. In this section *Pinus palustris* is the tree which is almost exclusively cut for timber. Lumbering has been carried on within a year and there are large amounts of tops and small logs which were left to lie on the ground and rot. The bark has begun to fall off in many places but the wood can hardly be called rotten, although it shows the effects of beginning decay. This rotting material is the home of an immense number of wood-boring insects, of which one, making a hole about one-fourth inch in diameter, is present in every log in large numbers. On many of these rotting logs were growing numerous fungi of the Agaricus type and evidently belonging to two quite different species. Specimens have been very kindly identified by Professor Chas. H. Peck, who found them to be *Flammula sapineus* Fr. and *Claudopus nidulans* (Pers.) Pk. Nothing was thought of the matter until it was noticed quite accidentally that they were growing out of the holes made by the large wood-borer. It was found that

the former fungus, *Flammula sapineus*, was present in larger numbers but both were plentiful. Many of the holes had no fungus growing in them, but with a single exception these two fungi were never found growing otherwise. This exception was a group of two or three individuals of *Flammula sapineus* which were found growing at the base of an upright but rotten pine tree. From their situation it was judged that they were growing on the rotted roots, but this was not ascertained. It was at first thought that the borers must have had something to do with the situation of the fungi, but everything seemed to discredit this supposition. On cutting the wood so that the interior was exposed it was found that the fungus mycelium invariably extended but a short distance into the burrows. In the burrows was always found a mass of wood fiber which had been chewed by the borer. This extended for several inches into the hole and was coarser the farther it was situated from the entrance. That located within about two inches of the entrance was more or less decayed and blackened. That situated farther in seemed to be perfectly sound and was uncolored. The pieces of material near the entrance were of the size of common sawdust while those located farthest from the entrance were often about one-fourth inch long. The mycelium was found only in the somewhat decayed material and never in the sound. The fungi seemed to feed on the decaying wood fiber, and apparently on nothing else. They are known as frequenters of decaying wood and this fact probably accounts for the limited distribution of their mycelium in the decayed outer portion and not in the fresh inner portion of the material. We apparently have a case where the spores of a previous crop of fungi were blown into the burrows and there germinated. They found their usual food material in sufficient quantities for them to complete their development and form fruiting organs. Immense numbers of spores were found under every

specimen of *Flammula sapineus*. The amount of rotting material in any one burrow would not more than fill an ordinary teaspoon, yet the size of the specimens growing in the holes was about the same as that of those found on the ground and agrees well with published measurements. Frequently there were several growing out of the same hole, but in such cases their size was apt to be less than where there was but a single one. This, one would naturally expect because of the limited amount of food material. The two species never grew together in the same hole although they very often grew in adjacent ones only a few inches apart. Most of the specimens simply filled the hole with a mat of mycelium at the base of their stem, but in some cases the stem was swollen into a sort of shoulder which extended over the edges of the hole so that the latter was completely hidden. Small fruiting bodies of *Claudopus nidulans* were found occasionally inside the holes.

There are undoubtedly many similar instances of fungi growing in the burrows of wood-boring insects, although there are very few published accounts concerning them. Probably the most unique instance of fungi which either habitually or occasionally grow in such situations is that of the "Ambrosia" fungi.* Certain of the wood-boring beetles prepare tiny beds and plant the spores. So far as is now known these beetles feed exclusively on the fruiting portions of the fungi. These beds are located in the interior of the beetle galleries and are very carefully attended to. The fungi are very small and are saprophytes. *Polyporus volvatus* Pk. is said by von Schrenk † to grow on conifers in holes made by the bark-boring beetle *Dendroctonus* sp. The spores lodge in the holes and germinate. The wood is soon rotted by the mycelium of the fungus and the fruiting bodies are formed at the entrances of the holes. It is also stated by von Schrenk that this fun-

* Bull. Div. Ent., U. S. Dept. Agric. n. s. 7: 9–31. (1897.)

† Bull. Div. Veg. Phys. & Path., U. S. Dept. Agric. 25: 13–14. (1900.)

gus occurs throughout the Northern States on coniferous trees, and, moreover, that it never occurs except in the beetle holes.* In the extreme west it is found on *Pseudotsuga douglasii* and *Sequoia sempervirens*. The latter tree is remarkably free from the attacks of fungi and would also be unaffected by this one were it not for these rather insignificant looking insects. *Polyporus pinicola* † also is known to gain entrance to trees by means of the holes of wood-boring insects. This is a particularly destructive wood-rotting fungus, and is responsible for much damage in lumber regions. In many cases there seems to be a direct relation between the distribution of the blueing fungus, *Ceratostomella pilifera* (Fr.) Wint., and the attacks of the wood-boring beetle, *Dendroctonus ponderosae*, on the wood of standing pine trees. Instances are also known where this fungus spread from the holes made by another wood-boring beetle.‡ Just what is the exact truth of the matter has not yet been determined in a satisfactory manner. As our knowledge of the fungi increases it is inevitable that many similar cases will be discovered.

## EXPLANATION OF PLATES.

From photographs by the writer.

Plate 25.— 1, View of a rotted log with *Flammula sapineus* growing in holes made by wood-borers. On the left side is seen a fungus growing out of a horizontal hole and showing the edges of the hole just below the stem. On either side are empty holes. 2, Specimen of *Flammula sapineus* in its natural position in the hole, slightly reduced. This gives a very good idea of the peculiar appearance of the fungi thus located. 3, Section of a log showing the character of the holes, the material contained therein, the extent of the mycelium into this material, and a group of three fungi, *Flammula sapineus*, growing from a single hole. The fungi are badly dried.

Plate 26.— 1, General appearance of a log with a specimen of *Flammula*

* MSS. in preparation.

† Bull. Div. Veg. Phys. & Path., U. S. Dept. Agric. 25: 14. (1900.)

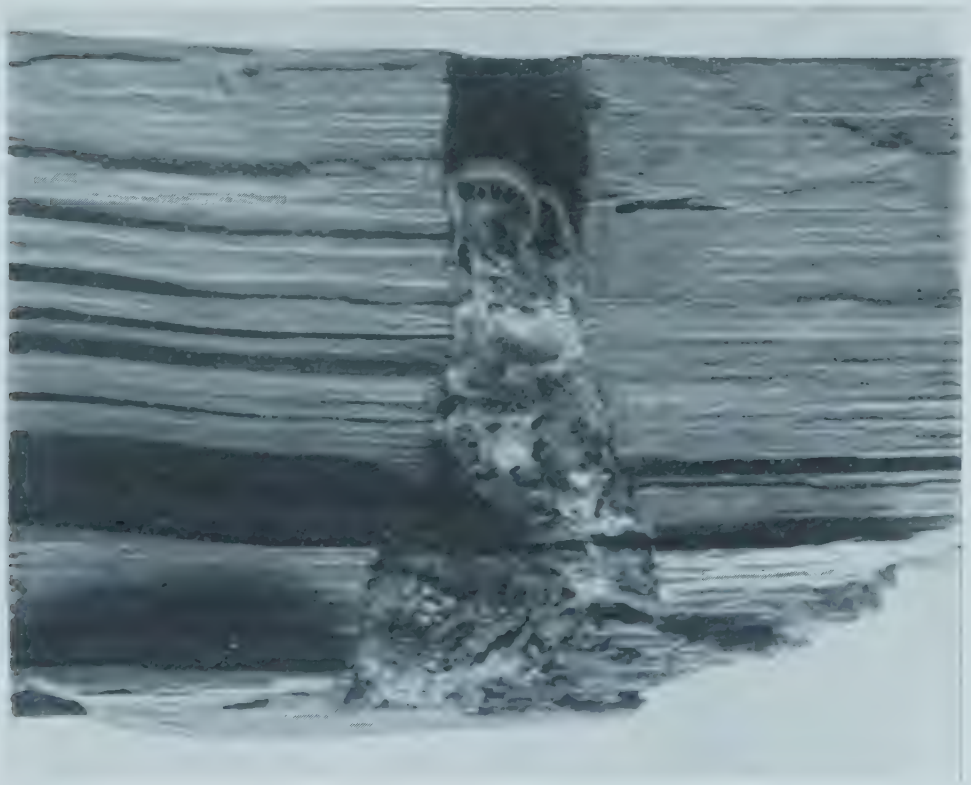
‡ Bull. Bureau Plant Industry, U. S. Dept. Agric. 36: 20. (1903.)

*sapineus* growing out of a hole. 2, Top view of three specimens of *Flammula sapineus* in a single hole. Taken at a distance of about four feet. Also shows the very numerous holes made by a small insect in the bark. 3, Specimen of *Flammula sapineus* growing on the ground at the foot of dead pine tree. Taken at a distance of about four feet. Compare with figure 2 of this plate.

Plate 27.— 1, Compound fruiting bodies of *Claudopus nidulans* growing out of holes made by wood-borer in a rotting log. The compound fruiting bodies are rather scarce. At the right is seen a single one, which is the more common form. 2, Wood of log cut and split so as to show the interior of a hole which has some small specimens of *Claudopus nidulans* growing inside. Also shows most of the mycelium which was in this burrow.

FLAMMULA SAPINEUS.

FLAMMULA SAPINEUS.



CLAUDOPUS NIDULANO.

## AN ECOLOGICALLY ABERRANT BEGONIA.*

BY WILLIAM TRELEASE.

While making observations on an undescribed *Agave* which grows on the vertical cliffs of a deep marble cañon a few miles above Iguala in the Mexican State of Guerrero, last summer, my attention was attracted by an abundant *Begonia* which grew in similar situations and differed from all of the other species of this genus that I had seen in possessing only a single radical leaf, through the sinus of which a few-flowered scape arose, — naked except for a rather small leaf-like bract subtending its single branch, and much smaller bracts in the inflorescence proper. Though my time was largely occupied with the *Agave* for which I had visited the cañon, herbarium and living specimens and photographs of the *Begonia* were secured, and a subsequent study of this material showed that the species belongs to the Section *Huszia* of modern writers, which Klotzsch regarded as a genus separable from *Begonia*, its only close ally being *B. monophylla* Pavon in DC. Prod. **15**[1]: 284. The latter, so far as I can learn, is known only from the type sheet in the Boissier herbarium, the label of which attributes it to New Spain. This group, *Huszia*, is that of the so-called tuberous begonias, some of which are now popular in cultivation, — nearly all of them coming from the Bolivian or Peruvian Andes. *B. monophylla* is said to produce a tuber 9 lines thick and to have a single petioled 12- to 15-nerved very shortly pilose leaf which is cordate or sometimes peltate, and rather large flowers.

On showing my material to Dr. J. N. Rose, whom I met in the City of Mexico, I learned that apparently the same

* Presented in abstract at the St. Louis meeting of the American Association for the Advancement of Science. — Science. n. s. **19**: 170.

species had been earlier collected by C. G. Pringle, and distributed in his set of 1902 under the manuscript name *B. unifolia* Rose: a fact verified at my return to St. Louis, — the distribution number being 8690.

Aside from its northern distribution for a species of the Section *Huszia*, the rather uncertain source of its closest relative, *B. monophylla*, and the single leaf which, like the latter, it produces, *B. unifolia* is of interest in that its single large leaf is closely applied to the rock or talus in the crevices of which it is rooted, so that its subterranean parts are thus given the same kind of protection afforded by the similarly appressed basal leaves of the stag-horn ferns, *Platycerium*.

I am indebted to Dr. Rose for a technical description of the species, which has been slightly modified with reference to my field notes, and the accompanying detailed drawings, — the habit illustration being from a photograph taken in the Iguala cañon.

BEGONIA UNIFOLIA Rose, n. sp.

Tuberous-rooted. Leaf single, lying close upon the ground, sessile, nearly orbicular, 10 to 30 cm. broad, with mostly 10 to 12 radiate once or twice forked principal veins, deeply cordate with overlapping lobes, deltoidly dentate with unequal teeth and frequently shallowly and broadly crenate, like the scape loosely white-villous with soft collapsible hairs that are mostly confined to the veins beneath but are scattered over the upper surface, and turn brown in drying. Scape 40 to 60 cm. high, emerging through the base of the sinus, usually solitary, at first simple and staminate, later with one or more pistillate branches above the middle which are subtended by suborbicular, deeply dentate often cuneate bracts sometimes 4 to 6 cm. in diameter: bractlets small, persistent, deeply cleft and lacerated. Flowers nearly white, glabrous, few at the end of the scape and its branch or branches, on slender glabrous or somewhat villous pedicels of about their own length. Staminate flowers about 25 mm. in diameter with 2 suborbicular often fimbriate sepals and 2 elliptical or spatulate narrower petals; stamens many, crowded, with globose-cuneate small anthers much shorter than the distinct filaments. Pistillate flowers longer-stalked, with 5 caducous rather narrow perianth segments scarcely half as long as those of the staminate flowers. Fruit 10 to 25 mm. long, 3-celled, with 3 wings, of which one is much broader than the others, truncate above, cuneate

or on the shorter capsules rounded at base: placentae 2-cleft, bearing seeds on both surfaces: styles 3, short, forked, with continuous loosely spiral papillate stigmas.

Ledges or banks of disintegrating limestone near Jojutla, Morelos, Mexico (Pringle, Aug. 30, 1902, no. 8690—type); similar situations on the mountains near Iguala, Guerrero (Pringle, Oct. 3, 1900, no. 9225; Trelease, Aug. 8, 1903). — The sheet taken as the type is deposited in the United States National Herbarium, as no. 396783.

## EXPLANATION OF PLATES.

Plate 28. — *Begonia unifolia*. — a, Plant, $\times \frac{1}{3}$. b, Staminate flower, $\times \frac{3}{4}$. c, stamens, $\times$ 3. d, Pistillate flower, $\times \frac{3}{4}$. e, Ovary, $\times$ 3. f, Cross section of ovary, $\times \frac{3}{4}$.

Plate 29. — Habit of growth of *B. unifolia*, from photograph taken in the Iguala cañon, above Naranjo.

BEGONIA UNIFOLIA.

BEGONIA UNIFOLIA.

## ABERRANT VEIL REMNANTS IN SOME EDIBLE AGARICS.

BY WILLIAM TRELEASE.

In 1884, when describing the North American representative of the European *Lepiota naucinus*, under the name *L. naucinoides*, Professor Peck mentioned the fact that the collar sometimes breaks loose from its attachment to the stem and becomes a movable ring upon it as in *L. procera*, or occasionally in old specimens becomes torn and disappears entirely, — statements that are repeated in several later accounts of the fungus.

A great abundance of this species in manured shrubbery borders, lawns, etc., of the Missouri Botanical Garden in the early autumn of 1902, has given opportunity to somewhat modify this account, and the accompanying photograms present the characters sufficiently well to require little explanatory test.

In the development of the button, in this species, the veil, which at first is rather thick, is drawn out to thinness toward both the stem and the margin of the pileus, so that in the larger number of specimens it tears away from the latter, leaving, however, a thin marginal edge, and remains as a rather large collar loosely attached to the stem. In less typical but still rather frequent cases the attachment to the pileus is firm enough in places so that the ring breaks apart at one or more points and the entire remains of the veil are carried out as easily detachable flecks or shreds on the margin of the cap. Occasional other specimens present veil characters intermediate between these two. It is not my experience that a ring, once formed, is likely to disappear in the ordinary aging of the plant after its development from the button. — Plates 30–34.

As this *Lepiota* is largely eaten, and prized by some

people as a delicacy, it has seemed to me worth while to call attention to these various forms of veil remains since aberrant specimens are properly open to suspicion as really pertaining to this species unless its variability is understood. It may not be amiss to say that in gathering it for the table the greatest care should be taken to avoid confusing with it the death-cup, *Amanita phalloides*, which is of similar coloring but may be known with certainty by its larger ruff-like collar and the presence of a loose bag or volva at base of the stem. Though hardly a table collector's character, it may be noted further that the gills of the *Amanita* remain white as the specimens age or when heated, while in the smooth *Lepiota* they turn to a light brown as the plants grow stale or when they are cooked.

Another comparable aberration is sometimes observed on the frequently cultivated large macaroon-flavored mushroom, *Agaricus amygdalinus*, which normally has a caducous large hanging ruff-like collar on the stem, but frequently has the veil entirely torn away from the latter, in which case its remnants are likely ultimately to break away from the pileus as well. — Plates 35, 36.

The delicate little *Hypholoma appendiculatum*, which is frequently found in lawns, is typically characterized by having the veil attached to the margin of the pileus in irregular broken shreds (Plate 37); but in American specimens these are so frequently lacking (Plate 38) as to have led to its renaming in this country as *H. incertum* Peck. Here, too, the behavior of the veil is so variable as to call for a recognition of its several forms, among which is sometimes to be found a delicate broken ring hanging from the stem (Plate 39).

## EXPLANATION OF PLATES.

From photographs by the author at St. Louis, Mo.

Plates 30, 31. — *Lepiota naucinus*, natural size. Typical specimens with conspicuous attached ring and remnants of the veil on the margin of the pileus.

Plate 32. — *Lepiota naucinus*, natural size. Specimens of both the convex and explanate forms, without ring, — the veil adhering in shreds to the margin of the pileus.

Plate 33. — *Lepiota naucinus*, natural size. Expanding specimens, on one of which a ring is forming while on the other the veil is adhering in shreds to the margin of the pileus.

Plate 34. — *Lepiota naucinus*, natural size. Expanding buttons. In one a detached ring is forming; in another the veil is adhering to the margin of the pileus; and in the third it is in the form of a torn, partly uncoiled ring, loosely attached to the stem and with one end adhering to the margin of the pileus.

Plate 35. — *Agaricus amygdalinus*, × ½. Aberrant specimen, with the veil breaking away from the stem instead of forming a large hanging ring as it typically does.

Plate 36. — *Agaricus amygdalinus*, reduced. Various veil remnants.

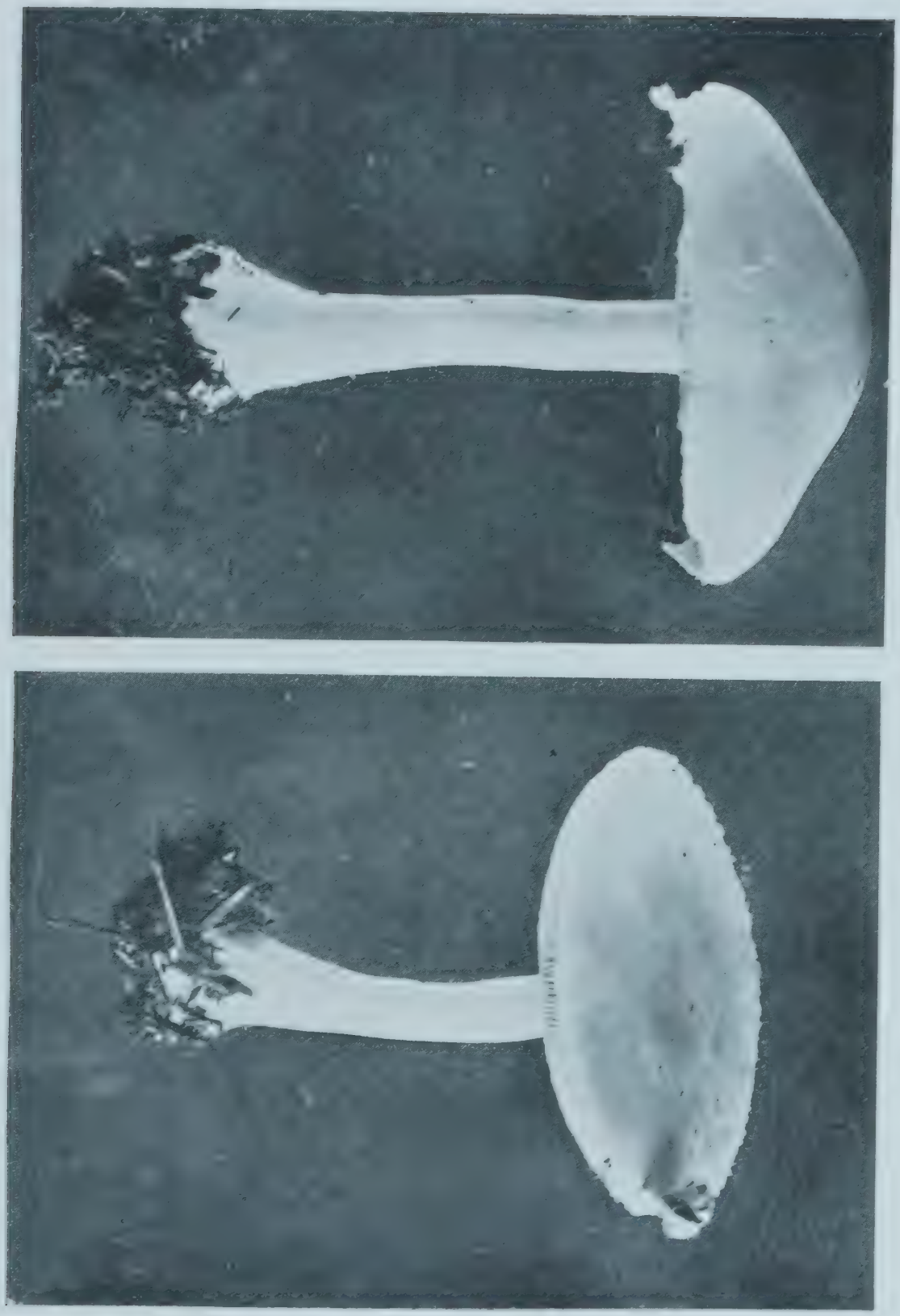
Plate 37. — *Hypholoma appendiculatum*, natural size. Typical specimen, with the veil attached in shreds to the margin of the pileus.

Plate 38. — *Hypholoma appendiculatum*, natural size. The more frequent American form, with the veil almost entirely gone from both stem and pileus.

Plate 39. — *Hypholoma appendiculatum*, natural size. Aberrant specimen with most of the veil remaining loosely attached to the stem in the form of an interrupted collar.

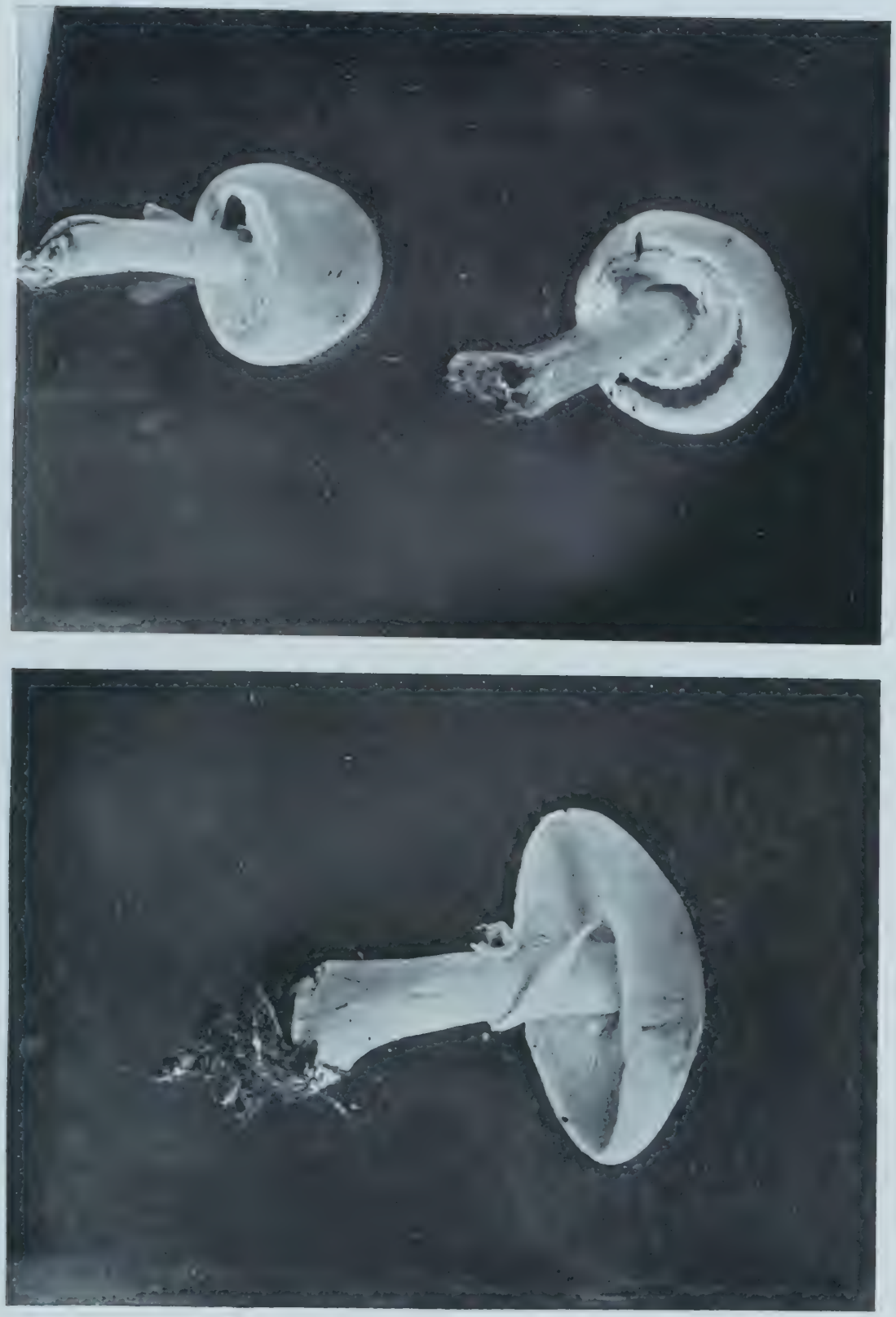
LEPIOTA NAUCINUS.

LEPIOTA NAUCINUS.



LEPIOTA NAUCINUS.

LEPIOTA NAUCINUS.



LEPIOTA NAUCINUS.

AGARICUS AMYGDALINUS.

AGARICUS AMYGDALINUS.

HYPHOLOMA APPENDICULATUM.

HYPHOLOMA APPENDICULATUM.

HYPHOLOMA APPENDICULATUM.

# LIBRARY CONTRIBUTIONS.

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BY WILLIAM TRELEASE.

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285. **Norton, J. B. S.** A revision of the American species of Euphorbia of the section Tithymalus occurring north of Mexico. Rept. Mo. Bot. Gard. **11**: 85–144. *pl. 11–52.* 1899.

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289. —— Jatropha. Cyclop. Amer. Hort. **2**: 844. 1900.

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317. —— The "bluing" and the "red rot" of the western yellow pine, with special reference to the Black Hills Reserve. U. S. Dept. Agric., Bu. Plant Ind., Bull. 36: 9–38. *pl. 1–14.* 1903.

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333. —— Alvin Wentworth Chapman. Amer. Naturalist. **33**: 643–646. 1899.

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350. —— The Yucceae. Rept. Mo. Bot. Gard. **13**: 27–133. *frontispiece* and *pl. 1–99.* 1902.

351. —— The Missouri botanical garden. Pop. Sci. Monthly. **62**: 193–221. 1903.

352. —— The Academy of science of St. Louis. — A biography. Pop. Sci. Monthly. **64**: 117–130. 1903.

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354. —— [Botanical notes and reviews]. American Naturalist. 1899–1903.

355. —— [Abstracts in North American phanerogamic botany]. Botanisches Centralblatt. 1900–1903.

356. —— [Secretary's abstracts of proceedings of the academy of science of St. Louis]. Science, through 1899–1903; occasionally in other journals.

**Trelease, W.** — See No. 362, below.

**Contributions** from the Shaw School of Botany, 13–19: —

357. **13.** VON SCHRENK, H. A sclerotioid disease of beech roots. Rept. Mo. Bot. Gard. **10**: 61–70. *pl. 55, 56.* 1899.

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360. **16.** VON SCHRENK, H. A severe sleet storm. Trans. Acad. Sci. St. Louis. **10**: 143–150. *pl. 10, 11.* 1900.

361. **17.** VON SCHRENK, H. A disease of the black locust (Robinia pseudacacia, L.). Rept. Mo. Bot. Gard. **12**: 21–31. *pl. 1–3.* 1901.

362. **18.** TRELEASE, W. Edible and poisonous mushrooms and toadstools. Rept. Hort. Soc. Mo. **43**: 224–241. 1900.

363. **19.** VON SCHRENK, H. Factors which cause the decay of wood. Journ. Western Soc. Engineers. **6**: [1–14]. *pl. 1–3.* 1901.

## A SUPPLEMENTARY LIST OF SERIAL PUBLICATIONS RECEIVED AT THE LIBRARY OF THE MISSOURI BOTANICAL GARDEN.*

BY WILLIAM TRELEASE.

Aargauische naturforschende Gesellschaft.

MITTEILUNGEN.* Aarau. O.

Académie des sciences et lettres de Montpellier.

MÉMOIRES, Section des sciences.* Montpellier. Q.

Académie des sciences inscriptions et belles-lettres de Toulouse.

BULLETIN.* Toulouse. O.

MÉMOIRES.* Toulouse. Q.

Académie des sciences, lettres et arts d'Arras.

MÉMOIRES.* Arras. O.

Académie hongroise des sciences. — See Magyar tudományos akadémia.

Académie internationale de géographie botanique.

CHRONIQUE trimestrielle.* Le Mans. O.

A single number has been issued.

Académie royale de Belgique.

ANNUAIRE.* Bruxelles. D.

BULLETIN, Classe des sciences.* Bruxelles. O.

Accademia di scienze . . . degli zelanti. — See Reale,.

Accademia pontificia dei nuovi Lincei. —See Pontificia accademia romana dei nuovi Lincei.

Acireale. — See Reale accademia di scienze, lettere e arti degli zelanti,.

Açores. — See Service météorologique des,.

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* This list includes titles not contained in the list published in Rept. Mo. Bot. Gard. **10**: 91–160, or changes in entries necessitated by material changes in the serials or societies publishing them or, in one case, by error in the earlier entry. Publications marked with an asterisk are received by way of exchange.

Agra and Oudh. — See British India.

Agricultural bulletin of the Straits and federated Malay states.* Singapore. O.

Agricultural news.* Barbados. Sq. Q.

Ain. — See Société des naturalistes de l'Ain.

Ajmere-Merwara. — See British India.

Akademia umiejętnósci w Krakowie.

Catalogue of Polish scientific literature.* Kraków. O.

Alaska agricultural experiment stations.

Bulletin.* Washington. O.

Alger. — See Société d'horticulture d'Alger.

Algérie. — See Revue horticole de l'Algérie.

American botanist. Binghamton. [Clute]. O.

American botanist.* San Diego. [Orcutt]. O.

Appears not to have gone beyond $1^2$. (Jan. 1900).

American florists. — See Society of,.

American inventor.* Washington. Sq. F.

Includes Popular science.

American park and outdoor art association.

[Report].* Boston. O.

American pharmaceutical association.

Proceedings.* Baltimore. O.

Ames botanical laboratory, North Easton, Mass.

Contributions.* Cambridge, O.

Amis des sciences et arts de Rochechouart.

Bulletin.* Rochechouart. O.

Andamans. — See British India.

Andes. — See Universidad de los,.

Annales mycologici. Berlin. Q.

Annali di botanica.* Roma. O.

Arboriculture.* Chicago. O.

Arkiv för botanik.* Stockholm. O.

Arras. — See Académie des sciences, lettres et arts d'Arras.

Assam. — See British India.

Aude. — See Société d'études scientifiques de l'Aude.

Audubon park. — See New Orleans.

Baar. — See Verein für Geschichte und Naturgeschichte der Baar etc.

Badischer Landesgartenbau-Verein. — See Rheinischer Gartenfreund.

Bahia. Secretaria de agricultura, viação, industria e obras públicas.

BOLETIM.* Bahia. O.

Baluchistan. — See British India.

Barbados. — See Imperial department of agriculture for the West Indies.

Barcelona. — See Real academia de ciencias y artes de,.

BEIHEFTE zum Tropenpflanzer.* Berlin. O.

See also Der Tropenpflanzer.

BEITRÄGE zur Biologie der Pflanzen. Breslau. Q.

BEITRÄGE zur wissenschaftlichen Botanik.* Stuttgart. O.

Belgique. — See Académie royale de,.

Bengal. — See British India.

Berar. — See British India.

Bergielunds botaniska trädgård.

ACTA horti bergiani.* Stockholm. Q.

Bern. — See Botanischer Garten in,.

Béziers. — See Société d'étude des sciences naturelles de,.

BILTMORE botanical studies.* Biltmore. O.

Biological club of the Ohio state university. — See O. S. U. naturalist.

BIOMETRIKA. Cambridge. Q.

Birmingham and Midland institute scientific society.

RECORDS of meteorological observations taken at the observatory, Edgbaston.* Birmingham. O.

Birmingham natural history and philosophical society.

PROCEEDINGS.* Birmingham. O.

Böhmen. — See Deutscher naturwissenschaftlich-medicinischer Verein für, etc.

BOLLETTINO del naturalista collettore, allevatore, coltivatore, acclimatore.* Siena. Q.

Bombay. — See British India.

Boston mycological club.

BULLETIN.* Cambridge. O.

Botanic station, Grenada.

ANNUAL report.* Saint George. F.

Botanical society of America.

PUBLICATIONS.* [New York]. O.

Botanische Staatsinstitute zu Hamburg.

JAHRESBERICHTE.* Hamburg. O.

MITTEILUNGEN.* Hamburg. Q.

Referring to various municipal entries under Hamburg.

Botanischer Garten in Bern.

SAMEN-Verzeichnis.* Bern. O.

Equivalent to the Hortus botanicus bernensis entry of the earlier list.

Bourbonnais. — See Revue scientifique du Bourbonnais.

Bourg. — See Jardin botanique alpin de la Linnaea.

Bremen. — See Naturwissenschaftlicher Verein zu,.

British Guiana. — See Royal agricultural and commercial society of,.

British India.

PROGRESS report of the forest survey branch.* Calcutta. F.

REVIEW of forest administration.* Calcutta. F.

Agra and Oudh. Department of land records & agriculture.

REPORT.* Allahabad. F.

Ajmere-Merwara.

ANNUAL report on the forest administration.* Calcutta. F.

Andamans.

PROGRESS report of forest administration.* [Simla]. F.

Assam.

PROGRESS report of forest administration.* Simla. F.

Baluchistan.

PROGRESS report of forest administration.* [Simla]. F.

Bengal.

PROGRESS report of forest administration in the lower provinces.* Calcutta. F.

Berar.

PROGRESS report of forest administration.* Simla. F.

Bombay presidency.

PROGRESS report of forest administration.* Simla. F.

Burma.

PROGRESS report of forest administration.* [Simla]. F.

Central provinces.

PROGRESS report of forest administration.* [Simla]. F.

Coorg.

PROGRESS report of forest administration.* Bangalore. F.

Madras presidency.

PROGRESS report of forest administration.* Simla. F.

——. Department of land records and agriculture.

REPORT on the operations.* Madras. F.

North-West provinces and Oudh. Forest department.

ANNUAL progress report of administration.* [Simla]. F.

The Punjab.

PROGRESS report of forest administration.* [Simla]. F.

British mycological society.

TRANSACTIONS. Worcester. O.

Brooklyn. — See Tree planting and fountain society of,.

Brooklyn institute of arts and sciences.

CHILDREN'S museum bulletin.* Brooklyn. O.

COLD spring harbor monographs.* Brooklyn. O.

SCIENCE bulletin.* New York. Q.

YEAR book.* Brooklyn. O.

BROTERIA. Revista de sciencias naturaes do collegio de S. Fiel.* Lisboa. O.

Bruxelles. — See Jardin botanique de l'état à,. — Société scientifique de,. — Université de,.

BRYOLOGIST.* Brooklyn. O.

Bucarest. — See Institut botanique de,.

Buitenzorg. — See 's Lands plantentuin.

Bulletin de pharmacie du Sud-Est.* Montpellier. O.

Burma. — See British India.

California. — See University of,.

Cambridge. — See Hortus cantabrigiensis academiae.

Campinas. — See Centro de sciencias, letras e artes de,.

Canada. Department of agriculture. Central experimental farm.

Report of the entomologist and botanist.* Ottawa. O.

Canada. — See Geological survey of,.

Canadian antiquarian and numismatic journal.* Montreal. O.

Cantabrigiensis. — See Hortus, academiae.

Cape of Good Hope. Department of agriculture.

Report of the government botanist and curator of the Cape government herbarium.* Cape Town. O.

Carnegie institution of Washington.

Year book.* Washington. Q.

Carnegie museum, Pittsburgh.

Publications.* Pittsburgh. O.

Cawnpore farm and other experiment stations in the united provinces.

Report.* Allahabad. F.

Replaces Cawnpore experimental farm.

Centraal bureau voor de kennis van de provincie Groningen en omgelegen streken.

Bijdragen.* Groningen. O.

Central provinces. — See British India.

Centre de la France. — See Revue scientifique du Bourbonnais, etc.

Centro de sciencias, letras e artes de Campinas.

Revista.* Campinas. Q.

Cěská k. ogród botaniczny w Krakowie. — See Hortus botanicus cracovensis.

Ceylon. — See Royal botanic gardens,.

Charkow. — See Universitas imperialis charkowiensis.

Chelsea physic garden.
INDEX seminum.* London. O.
Chicago academy of sciences.
SPECIAL publications.* Chicago. O.
Christiania. — See Physiographiske forening i,.
City of Des Moines.— See Des Moines.
City of Detroit. Commissioners of parks and boulevards.
ANNUAL report.* Detroit. O.
City of Mansfield, Ohio. Board of park commissioners.
ANNUAL report. [Mansfield]. O.
CIVIC improvement bulletin.* St. Louis. Sq. O.
Cold spring harbor monographs.—See Brooklyn institute of arts and sciences.
COLMAN'S rural world.* St. Louis. F[6].
Coorg.— See British India.
Cornell university. College of agriculture.
FARMERS' wives' reading course.* Ithaca. O.
—— Supplement.* Ithaca. O.
HOME nature-study course.* Ithaca. O.
Costa Rica.— See Sociedad nacional de,
COUNTRY life in America.* New York. F[4].
Cracovensis. — See Hortus botanicus,.
Croatica. — See Societas historico-naturalis,.
Croyden natural history and scientific society.
PROCEEDINGS and transactions.* Croyden. O.
Replaces Croyden microscopical and natural history club.
Delaware. — See Peninsula horticultural society.
Derpt .— See Jurjev.
Des Moines. Board of park commissioners.
ANNUAL report.* Des Moines. O.
Detroit. — See city of,.
Deutsch-schweizerische Versuchsstation und Schule für Obst-, Wein- und Gartenbau in Wädensweil.
JAHRESBERICHT.* Zürich. O.
Deutsche dendrologische Gesellschaft.
MITTEILUNGEN.* Poppelsdorf-Bonn. Q.

Deutsche Forstmänner. — See Deutscher Forstverein.

Deutscher Forstverein.

BERICHT. Berlin. O.

Deutscher naturwissenschaftlich-medicinischer Verein für Böhmen "Lotos" in Prag.

SITZUNGSBERICHTE.* Prag. O.

Donaueschingen. — See Verein für Geschichte und Naturgeschichte . . . in,.

Drainage journal. — See Irrigation age.

Dresden. — See Genossenschaft "Flora."

Dublany. — See Hortus botanicus academicus dublanensis.

Dunoise. — See Société,.

East Kent natural history society.

REPORT and transactions.* Canterbury. Sq. O.

Formerly Scientific and natural history society.

Ecole supérieure de l'agriculture. — See Institut national agronomique.

Edgbaston. — See Birmingham.

Edinburgh. — See Royal society of,.

Elbeuf. — See Société d'étude . . . d'Elbeuf.

ERFURTER Führer im Gartenbau.* Erfurt. Sq. Q.

Erlangen. — See Physikalisch-medicinische Societät in,.

Española. — See Sociedad, de historia natural.

Essex institute.

ANNUAL report.* Salem. O.

Estada de Michoacán. — See Michoacán.

FARM and ranch.* Dallas. F4.

FARMERS voice and National rural.* Chicago. F4.

Replaces National rural.

Flora. — See Genossenschaft "Flora."

FLORA and sylva. London. Sq. F.

FLORAL life.* Philadelphia. F4.

Continuation of Meehan's monthly.

Florida state horticultural society.

TRANSACTIONS. De Land. Sq. O.

Formerly Proceedings.

Forestry and irrigation.* Washington. Q.
Replaces The Forester.
Forestry quarterly.* Ithaca. O.
Freiburg. See Grossherzoglich-badische . . . Universität. — Naturforschende Gesellschaft in,.
Fruit experiment stations of Ontario.
Annual report.* Toronto. O.
Fruit-growers' association of Ontario.
Annual report.* Toronto. O.
—— —See Fruit experiment stations of Ontario.
Gärtnerische Rundschau.* Wien. Sq. F.
Gärtnerverein "Hortolonia." — See Gärtnerische Rundschau.
Gartenfreund.* Karlsruhe. O.
Replaces Rheinischer Gartenfreund.
Geisenheim. — See Königliche Lehranstalt . . . zu,.
Genève. — See Société botanique de,.
Genossenschaft "Flora."
Sitzunsgberichte und Abhandlungen.* Dresden. O.
Geographical society of Philadelphia.
Bulletin.* Philadelphia. O.
Geological survey of Canada.
Contributions from the herbarium.* [Ottawa]. O.
Geological survey of New Jersey.
Annual report of the state geologist.* Trenton. O.
Final report of the state geologist.* Trenton. O.
Georgia. State college of agriculture and mechanic arts. Georgia experiment station.
Annual report.* Experiment. O.
Georgia state horticultural society.
Proceedings.* Atlanta. O.
Ginseng garden.* Scranton. O.
Glasgow. — See Royal philosophical society of,.
Gouvernements Kina-onderneming in de residentie Preanger-Regentschappen.
Jaarverslag.* Batavia. Q.

Government botanical gardens, Saharanpur and Mussoorie.

REPORT.* Allahabad. F.

Formerly Saharanpur and Arnigadh.

Grenada. — See Botanic station,.

Groningen. — See Centraal bureau voor de kennis van de provincie, etc.

Grossherzoglich-badische Albert-Ludwigs-Universität. Botanischer Garten der Universität Freiburg i. B.

SAMEN-Verzeichnis.* Freiburg i. B. Sq. Q.

Equivalent to entry in earlier list.

Guiana. — See British,.

Haarlem. — See Koloniaal museum te,.

Hamburg. — See Verein für naturwissenschaftliche Unterhaltung zu,.

———. Botanischer Garten; Botanisches Museum; Laboratorium für Waarenkunde; Abteilung für Samencontrol; Abteilung für Pflanzenschutz. — See Botanische Staatsinstitute zu,.

Hamilton scientific association.

JOURNAL and proceedings.* Hamilton. O.

Replaces Hamilton association.

Hautes-Alpes. — See Société d'études des,.

Hawaii agricultural experiment station.

BULLETIN.* Washington. O.

Havraise. — See Société, d'études diverses.

Heidelberg. — See Universität,.

Hérault. — See Société d'horticulture . . . de l'Hérault.

Hietzing. — See Verein der Gärtner und Gartenfreunde in,.

Historical society of Montana.

CONTRIBUTIONS.* Helena. O.

Historischer Verein von Oberpfalz und Regensburg.

VERHANDLUNGEN.* Regensburg. O.

HOME and flowers.* Springfield, O. Q.

Replaces How to grow flowers.

Hongroise. — See Académie, des sciences.

Horta. — See Service météorologique des Açores.

Hortolonia. — See Gärtnerische Rundschau.
Hortus bergianus. — See Bergielunds botaniska trädgård.
Hortus botanicus academicus dublanensis.
SELECTUS seminum sporarumque.* [Dublany-Lemberg]. O.
Hortus botanicus cracovensis.
SELECTUS e seminario.* Cracovie. Sq. Q.
Hortus botanicus lundensis.
INDEX seminum.* Lund. O.
Hortus botanicus matritensis.
CATALOGUS seminum.* Madrid. O.
Hortus botanicus tiflisiensis. — See Tifliskiĭ botanicheskiĭ sad.
Hortus cantabrigiensis academiae.
DELECTUS seminum.* Cantabrigiae. O.
Equivalent to Cambridge university entry in earlier list.
Hortus thenensis.
ICONES selectae.* Bruxelles. Q.
How to grow flowers. — See Home and flowers.
Hull botanical laboratory. — See University of Chicago.
Hrvatsko naravoslovno društvo. (Societas historico-naturalis Croatica).
GLASNIK.* Zagreb. O.
Idaho. — See University of,.
Imperatorskiĭ jurjevskiĭ universitet. Hortus botanicus.
INDEX seminum.* [Derpt]. Q.
Equivalent to Delectus of earlier list.
TRUDY (Acta).* Jurjev [Derpt]. O.
Imperial department of agriculture for the West Indies.
PAMPHLET series.* [Barbados]. D.
SUGAR-cane experiments in the Leeward islands.* Barbados. F.
—— — See Agricultural news. — West Indian bulletin.
Barbados. REPORT of the agricultural work.* Barbados. F.
India. — See British India.

Indre-et-Loire. — See Société d'agriculture, sciences arts et belles-lettres du département d'Indre-et-Loire.

Innsbruck. — See Naturwissenschaftlich-medizinischer Verein in,.

Institut agricole de Lausanne. Station météorologique du Champ-de-l'Air.

OBSERVATIONS météorologiques.* Lausanne. O.

Institut botanique de Bucarest.

BULLETIN de l'herbier.* Bucuresci. O.

Institut agronomique de Moscou.

ANNALES.* Moskwa. Q.

Institut botanique de Buitenzorg. — See 's Lands plantentuin.

Institut national agronomique. (Ecole supérieure de l'agriculture).

ANNALES.* Paris. O.

Instituto fisico-geográfico de Costa Rica.

BOLETIN.* San José. Q.

Instituto médico nacional.

ANALES.* México. Q.

INTERNATIONAL catalogue of scientific literature. M. Botany. London. O.

International society of arboriculture. — See Arboriculture.

Iowa geological survey.

BULLETIN.* Des Moines. O.

IRISH naturalist.* Dublin. O.

IRRIGATION age.* Chicago. Sq. Q.

Replaces Drainage journal.

Isère. — See Société de statistique des sciences naturelles et des arts industriels du département de l'Isère.

ITALIA orticola.* Napoli. Q.

Jamaica. Board of agriculture and department of public gardens and plantations.

ANNUAL report.* Kingston. F.

Jardin botanique alpin de la Linnaea à Bourg-St.-Pierre.

CATALOGUE des plantes.* Genève. Q.

RAPPORTS annuels.* Genève. O.

Jardin botanique de l'état à Bruxelles.
BULLETIN.* Bruxelles. Q.
Jardin botanique de Rio de Janeiro.
CONTRIBUTIONS.* Rio de Janeiro. F.
Jardin botanique de Saigon.
CATALOGUE des graines.* Saigon. Q.
Jardin impérial botanique de St.-Pétersbourg.
BULLETIN.* S.-Peterburg. Q.
Johns Hopkins university. Botanical laboratory.
CONTRIBUTIONS.* [Baltimore]. O.
JOURNAL d'agriculture tropicale. Paris. Q.
JOURNAL des naturalistes.* Macon. Q.
JOURNAL of mycology. Columbus. O.
Jurjev. — See Imperatorskiĭ jurjevskiĭ universitet.
Kagok. — See Proefstation voor suikerriet . . .,.
Kaiserlich-königlich deutsche Universität in Prag. Botanischer Garten.
VERZEICHNIS . . . Sämereien und Pflanzen.* Prag. O.
Replaces Sämereien.
—— —— landwirtschaftlich-chemische Versuchsstation in Wien.
BERICHT.* [Wien]. O.
—— ——landwirtschaftlich-bakteriologische und Pflanzenschutzstation in Wien. — See K. k. landwirtschaftlich-chemische Versuchsstation.
Kaiserlich-königliche Universität in Wien. Botanischer Garten.
VERZEICHNIS von Sämereien.* Wien. O.
Kaiserliche Akademie der Wissenschaften in Wien.
MITTHEILUNGEN der Erdbeben-Commission.* Wien. O.
Kaiserliche Gesundheitsamt. Biologische Abtheilung.
ARBEITEN. Berlin. Q.
Kansas pharmaceutical association.
PROCEEDINGS.* Topeka. O.
Kansas university science bulletin.* Lawrence. O, Q.
Replaces Kansas university quarterly.

Königlich-bayerisch agrikulturbotanische Anstalt in München. — See Praktische Blätter für Pflanzenbau etc.

Königliche botanische Gesellschaft in Regensburg.

DENKSCHRIFTEN.* Regensburg. O.

Formerly K. bayerisch botanische Gesellschaft.

Königliche Lehranstalt für Wein-, Obst- und Gartenbau zu Geisenheim a. Rh.

BERICHT.* Wiesbaden. O.

Koloniaal museum te Haarlem.

CATALOGUS.* Amsterdam. O.

MEDEDEELING uit het laboratorium.* Amsterdam. O.

Kolonial-wirtschaftliches Komitee.

Jahresbericht.* Berlin. O.

—— — See Der Tropenpflanzer, and Beihefte.

Kongliga svenska vetenskaps-akademien. — See Arkiv för botanik. — Bergielunds botaniska trädgård.

Koninklijke akademie van wetenschappen te Amsterdam.

PROCEEDINGS, Section of sciences.* Amsterdam. Q.

Krakowie. — See Akademia umiejętnósci w,. — Cěská k. ogród botaniczny w,. — Hortus botanicus cracovensis.

Laboratoire des essais des semences de l'état à Wageningen. Jardin d'expérience.

CATALOGUE des graines.* Wageningen. Sq. Q.

Land of sunshine. — See Out west.

's Lands plantentuin.

BULLETIN de l'institut botanique de Buitenzorg.* Buitenzorg. Q.

LANDWIRTSCHAFTLICHE Jahrbücher.* Berlin. Q.

LANDWIRTSCHAFTLICHEN Versuchs-Stationen. Berlin. O.

Lausanne. — See Institut agricole de,.

Leeds philosophical and literary society.

ANNUAL report.* Leeds. O.

Leeward islands. — See Imperial department of agriculture for the West Indies.

Lemberg. — See Dublany. — Ukrainische . . . Gesellschaft der Wissenschaften in,.

Lincei. — See Pontificia accademia . . dei nuovi,. — Reale accademia dei,.

Linnaea. — See Jardin botanique alpin de la Linnaea.

Lloyd library of botany, pharmacy and materia medica.

BULLETIN. Mycological series.* Cincinnati. O.

BULLETIN. Pharmacy series.* Cincinnati. Q.

BULLETIN. Reproduction series.* Cincinnati. Q.

CATALOGUE of periodical literature.* Cincinnati. O.

MYCOLOGICAL notes.* Cincinnati. O.

REPORT.* Cincinnati. O.

London. — See museums and lecture rooms syndicate.

Lotos. — See Deutscher naturwissenschaftlich-medicinischer verein . . . "Lotos."

Lucknow provincial museum.

ANNUAL report.* Allahabad. F.

Lund. — See Hortus botanicus lundensis.

Lyon. Hortus municipalis.

INDEX fructuum et seminum.* Lyon. O.

Equivalent to entry under Lyon in earlier list.

Lyon. — See Muséum d'histoire naturelle de,.

Macon. — See Société d'histoire naturelle de,.

Madras. — See British India.

Madrid. — See Hortus botanicus matritensis.

MAGYAR botanikai lapok.* Budapest. O.

Magyar nemzeti muzeum.

ANNALES historico-naturales musei nationalis hungarici.* Budapest. O. (Természetrajzi osztályainak folyóirata.)

Magyar tudományos akadémia.

Rapport sur les travaux de l'académie hongroise des sciences.* Budapest. O.

—— — See Mathematische und naturwissenschaftliche Berichte aus Ungarn.

Maine. — See University of Maine.

Malay states. — See Straits and federated,.

Manchester museum, Owens College.

PUBLICATIONS.* Manchester. O.

Mansfield. — See City of,.

Marine biological laboratory, Woods Holl, Mass.

BIOLOGICAL bulletin.* Lancaster, Pa. Q.

Maryland agricultural experiment station. State horticultural department.

CIRCULAR bulletin.* [College Park]. O.

Maryland state horticultural society.

REPORT.* Baltimore. O.

Matritensis. — See Hortus botanicus,.

MAZAMA.* Portland, Oregon. Q.

Meehan's monthly. — See Floral life.

Meuse. — See Société des naturalistes et archeologves du Nord de la,.

Mexico. — See Museo nacional de,. — República mexicana.

Michigan academy of science.

REPORT.* Lansing. O.

Michigan forestry commission.

ANNUAL report.* Lansing. O.

Michoacán de Ocampo.

PERIÓDICO oficial del gobierno.* Morelia. F[5].

Minnesota seaside station. — See Postelsia.

MISSOURI and Arkansas farmer and fruitman. Kansas City. F[5].

Missouri bureau of geology and mines.

BIENNIAL report of the state geologist.* Jefferson City. O.

Equivalent to former entry under State of Missouri.

Missouri state fruit experiment station, Mountain Grove, Mo.

BULLETIN.* West Plains. O.

MODERN Mexico.* New York & Mexico City. Sq. F.

MOIS scientifique.* Paris. O.

Montana [agricultural] experiment station.

REPORT of the botanical department.* Bozeman. O.

Montana state board of horticulture.
BIENNIAL report.* Helena. O.
Montana. — See Historical society of,.
Montpellier. — See Académie des sciences et lettres de,.
Montreal.— See Numismatic and antiquarian society of,.
Moscow. — See Institut agronomique de,.
Mount Holyoke college. Clara Leigh Dwight gardens.
EXCHANGE list.* South Hadley. Sq. Q.
München. — See Königlich-bayerisch agrikulturbotanische Anstalt in,.
MUHLENBERGIA.* Lancaster, Pa. O
Museo nacional de México.
ANALES.* México. Q.
BOLETIN.* México. Q.
Museu nacional do Rio de Janeiro.
ARCHIVOS.* Rio de Janeiro. Sq. F.
Museu paraense de historia natural e ethnographia.
ARBORETUM amazonicum. Para. Sq. F.
Muséum d'histoire naturelle de Lyon.
ARCHIVES.* Lyon. Sq. $F^4$.
Museum national hungaricum. — See Magyar nemzeti muzeum.
Museums and lecture rooms syndicate.
ANNUAL report.* [London]. Sq. Q.
Mussoorie. — See Government botanical gardens, Saharanpur and,.
Nantes. Jardin des plantes.
CATALOGUE des graines.* Nantes. O.
Equivalent to entry under Nantes in former list.
Napoli.— See Regia università di,.
National academy of sciences.
MEMOIRS.* Washington. Sq. Q.
REPORT.* Washington. O.
NATIONAL druggist.* St. Louis. Q.
NATIONAL geographic magazine. Washington. Sq. Q.
National geographic society. — See National geographic magazine.

National rural. — See Farmers voice.

Die Natur. — See Naturwissenschaftliche Wochenschrift.

Naturforschende Gesellschaft in Emden.

KLEINE Schriften.* Emden. O.

Naturforschende Gesellschaft in Freiburg.— See Société fribourgeoise.

Naturforscher Verein zu Riga.

ARBEITEN.* Riga. O.

Naturhistorische Gesellschaft zu Nürnberg.

JAHRESBERICHT.* Nürnberg. O.

Issued in the Abhandlungen, separately paged.

Naturwissenschaftlich-medizinischer Verein in Innsbruck.

BERICHT.* Innsbruck. O.

Naturwissenschaftlicher Verein zu Bremen.

BEITRÄGE zur nordwest deutschen Volks- und Landeskunde.* Bremen. O.

NATURWISSENSCHAFTLICHE Wochenschrift.* Jena. Q.

Naturwissenschaftlicher Verein zu Regensburg.

BERICHTE.* Regensburg. O.

Nebraska academy of sciences.

PUBLICATIONS.* Lincoln. O.

Neuchatel. — See Société neuchateloise.

New Hampshire college. Agricultural experiment station.

NATURE study leaflet.* Durham. O.

TECHNICAL bulletin.* Durham. O.

New Jersey. — See Geological survey of,.

New Jersey agricultural college experiment station. Biological department.

REPORT.* Trenton, etc. O.

New Orleans. Audubon park.

YEAR book.* New Orleans. O.

NEW phytologist.* London. O.

New South Wales. Botanic gardens and domains.

REPORT.* Sydney. F.

—— — See Sydney.

[New York]. Forest, fish and game commission.

REPORT.* Albany. Q.

[New York]. Forest preserve board.
ANNUAL report.* Albany. O.
New York botanical garden.
CONTRIBUTIONS.* New York. O.
JOURNAL. Lancaster. O.
MEMOIRS. New York. Q.
New Zealand department of agriculture.
ANNUAL report.* Wellington. O.
LEAFLETS for farmers.* Wellington. O, Q.
LEAFLETS for gardeners and fruit growers.* [Wellington]. Q.
Division of biology and pomology.
REPORT.* Wellington. O.
Experimental stations.
REPORTS.* Wellington. O.
Nord de la France. — See Société linnéenne du,.
Nord de la Meuse. — See Société des naturalistes et archéologves du,.
North Carolina state board of agriculture.
BULLETIN.* Raleigh. O.
North-West provinces and Oudh. — See British India.
Nürnberg. — See Naturhistorische Gesellschaft zu,.
Numismatic and antiquarian society of Montreal. — See Canadian antiquarian.
NYT magazin for naturvidenskaberne.* Christiania. O.
O. S. U. naturalist. — See Ohio naturalist.
Oberösterreich. — See Verein der Gärtner und Gartenfreunde Oberösterreichs.
Oberpfalz und Regensburg. — See Historischer Verein von,.
OHIO farmer.* Cleveland. F4.
OHIO mycological bulletin.* Columbus. O.
Included in Ohio state university, university bulletins, botanical series.
OHIO naturalist.* Columbus. O.
Ohio state academy of science.
ANNUAL report.* [Wooster]. O.
SPECIAL papers.* Wooster. O.

Ohio state archaeological and historical society.
ANNUAL report.* Columbus. O.
OHIO archaeological and historical quarterly.* Columbus. O.
Ohio state university.
UNIVERSITY bulletins. Botanical series.* Columbus. O.
—— Contributions from the department of zoology and entomology.* Columbus. O.
—— Biological club. — See Ohio naturalist.
Oklahoma agricultural and mechanical college. Agricultural experiment station.
REPORT.* Stillwater. O.
Omaha. Board of park commissioners.
ANNUAL report.* Omaha. O.
Ontario. — See Fruit-growers' association of,. — Fruit experiment stations of,.
Oregon. — See State of,.
Oudh. — See British India. Agra and,; Northwest provinces and,.
Ouest. — See Société scientifique et médicale de l'Ouest.
Owens college. — See Manchester museum.
OUT WEST.* Los Angeles. O.
Replaces Land of sunshine.
Palermo. — See Reale accademia di scienze, lettere e belle arti di,.
Paraense. — See Museu,.
Paris. — See Société linnéenne de,.
PARK and cemetery and landscape gardening.* Chicago. F.
Replaces Park and cemetery.
Peninsula horticultural society.
TRANSACTIONS.* Dover, Del. O.
Peradeniya. — See Royal botanic gardens, Ceylon.
Perak museum.
REPORT.* [Taiping]. F.
Philadelphia. — See Geographical society of,.
Philadelphia mycological center.
BULLETIN.* Philadelphia. O.

[Philippine islands.]
Bureau of agriculture.
BULLETIN.* Manila. Q.
Forestry bureau.
BULLETIN.* Manila. O.
REPORT.* [Manila]. O.

Philosophical society of Glasgow. — See Royal philosophical society.

Physikalisch-medicinische Societät in Erlangen.
SITZUNGSBERICHTE.* Erlangen. O.

Physiografiske forening i Christiania. — See Nyt magazin for naturvidenskaberne.

Pisa. — See Regia università di,.

Pittsburgh. — See Carnegie museum,.

Ponta Delgada. — See Service météorologique des Açores.

Pontificia accademia romana dei nuovi Lincei.
ATTI.* Roma. Q.

Popular science. — See American inventor.

Porto Rico agricultural experiment station.
BULLETIN.* Washington. O.

POSTELSIA. The year book of the Minnesota seaside station. St. Paul. O.

PRACTICAL fruit grower.* Springfield, Mo. Sq. F[4].
Replaces The Southwest.

Prag. — See Deutscher naturwissenschaftlich-medicinischer Verein . . . in,.

PRAKTISCHE Blätter für Pflanzenbau und Pflanzenschutz. Stuttgart. O.
Continuation of Praktische Blätter für Pflanzenschutz.

Proefstation voor cacao te Salatiga.
BULLETIN.* Semarang-Soerabaia. O.

Proefstation voor suikerriet in West-Java. "Kagok" te Pekalongan.
BULLETIN.* Tegal. O.
VERSLAG.* Semarang. O.

[Providence, R. I.]. Park commissioners.
ANNUAL report.* Providence. O.

Provinciaal utrechtsch genootschap van kunsten en wetenschappen.

Aanteekeningen.* Utrecht. O.

Verslag.* Utrecht. O.

Punjab. — See British India.

Real academia de ciencias y artes de Barcelona.

Boletín.* Barcelona. Sq. F.

Memorias.* Barcelona. Sq. F.

[Miscellanea].* Barcelona. Nar. S–Q.

Nomina del personal academico.* Barcelona. Nar. S.

Reale accademia dei Lincei.

Rendiconti delle sedute solenni.* Roma. Sq. Q.

Reale accademia di scienze, lettere e arti degli zelanti, Acireale.

Atti e rendiconti. Memorie della classe di scienze. Rendiconti.* Acireale. O.

Formerly Accademia. . . .

Reale accademia di scienze, lettere e belle arti di Palermo.

Bullettino.* Palermo. F.

Regensburg. — See Historischer Verein von Oberpfalz und,. — Königliche botanische Gesellschaft in,. — Naturwissenschaftlicher Verein zu,.

Regia università di Napoli. Orto botanico.

Bullettino.* Napoli. O.

[R. università di Pisa]. Regius hortus botanicus pisanus.

Enumeratio seminum.* [Pisa]. O.

R. università degli studi di Roma. Hortus.

Index seminum.* Roma. O.

R. universitas romana.— See Regia università . . . di Roma.

Regius hortus botanicus pisanus. — See Regia università di Pisa.

República de el Salvador. Museo nacional.

Anales.* San Salvador. O.

[República mexicana]. Secretaría de fomento.

Boletin.* México. Sq. O.

[République française]. Ministère de l'agriculture. — See Institut national agronomique.

Revue horticole de l'Algérie.* Alger-Mustapha. O.
Revue scientifique du Bourbonnais et du centre de la France.* Moulins. O.
Rheinischer Gartenfreund. — See Gartenfreund.
Riga. — See Naturforscher Verein zu,.
Rio de Janeiro. — See Jardin botanique de,. — Museu nacional do,.
Rivista italiana di scienze naturali. — See Bollettino del naturalista.
Rochechouart. — See Amis des sciences et arts de,.
Romana. — See Pontificia accademia, dei nuovi Lincei.
Rosen-Zeitung.* Frankfurt a. M. Q.
Royal agricultural and commercial society of British Guiana.
Journal.* Demerara. O.
Replaces Timehri of earlier list.
Royal botanic garden. Edinburgh.
Notes.* Glasgow. O.
Royal botanic gardens, Ceylon.
Administration reports.* Peradeniya. F.
Annals.* Peradeniya. O.
Royal geographical society of Australia. South Australian branch.
Proceedings.* Adelaide. O.
Royal philosophical society of Glasgow.
Proceedings.* Glasgow. O.
Royal society of Edinburgh.
Proceedings.* Edinburgh. O.
Rural Californian.* Los Angeles. Sq. F.
Ruthenische Ševčenko-Gesellschaft. — See Ukrainische,.
Saharanpur. — See Government botanical gardens, and Mussoorie.
Saigon. — See Jardin botanique de,.
Salatiga. — See Proefstation . . . te,.
Salvador. — See República de el Salvador.
School science.* Chicago. O.

Schweizerische naturforschende Gesellschaft in Zofingen. — See Aargauische naturforschende Gesellschaft.

Schweizerische Versuchsstation . . . in Wädensweil. — See Deutsch-schweizerische Versuchsstation.

Scottish microscopical society.

PROCEEDINGS.* Edinburgh. O.

Service météorologique des Açores.

Observatoire de Horta.

RÉSUMÉ des observations.* [Ponta Delgada]. Sheets.

VARIATION diurne de la pression atmosphérique.* [Ponta Delgada]. Sheets.

Observatoire de Ponta Delgada.

RÉSUMÉ des observations.* [Ponta Delgada]. Sheets.

VARIATION diurne de la pression atmosphérique.* [Ponta Delgada]. Sheets.

Ševčenko-Gesellschaft. — See Ukrainische (ruthenische),.

Siebenbürgische Landeskunde. — See Verein für,.

Smithsonian institution. U. S. national museum.

CONTRIBUTIONS from the United States national herbarium.* Washington, O.

Formerly published by the U. S. department of agriculture.

Sociedad española de historia natural.

BOLETÍN.* Madrid. Q.

MEMORIAS.* Madrid. Q.

Sociedad nacional de agricultura.

BOLETIN.* Lima. Q.

Sociedad nacional de agricultura de Costa Rica. — See Instituto fisico-geográfico de Costa Rica.

Societas historico-naturalis croatica. — See Hrvatsko naravoslovno društvo.

Société botanique de Genève.

COMPTE rendu des séances.* [Genève]. O.

Société d'agriculture, sciences arts et belles-lettres du département d'Indre-et-Loire.

ANNALES.* Tours. Q.

Société d'émulation du département des Vosges.
ANNALES. Epinal, Paris. O.
Société d'étude des sciences naturelles d'Elbeuf.
BULLETIN.* Elbeuf. Q.
Société d'étude des sciences naturelles de Béziers.
BULLETIN.* Béziers. Q.
Société d'études des Hautes-Alpes.
BULLETIN.* Gap. Q.
Société d'études scientifiques de l'Aude.
BULLETIN.* Carcassonne. O.
Société d'histoire naturelle de Macon.
BULLETIN trimestriel.* Macon. Q.
—— — See Journal des naturalistes.
Société d'histoire naturelle de Toulouse.
BULLETIN.* Toulouse. O.
Société d'horticulture d'Alger. — See Revue horticole de l'Algérie.
Société d'horticulture et d'histoire naturelle de l'Hérault.
ANNALES.* Montpellier. O.
Société de statistique des sciences naturelles et des arts industriels du département de l'Isère.
BULLETIN.* Grenoble. Q.
Société des naturalistes de l'Ain.
BULLETIN.* Bourg. O.
Société des naturalistes et archéologves du Nord de la Meuse.
MÉMOIRES.* Montmédy. O.
Société des sciences historiques et naturelles de Semur-en-Auxois (Côte-d'Or).
BULLETIN.* Semur-en-Auxois. Q.
Société des sciences naturelles de Neuchatel. — See Société neuchateloise des sciences naturelles.
Société des sciences naturelles et d'enseignement populaire de Tarare.
BULLETIN.* Charlieu. O.

Société dunoise archéologie, histoire, sciences et arts.
BULLETIN.* Chateaudun. Q.
Société fribourgeoise des sciences naturelles.
MÉMOIRES, Botanique.* Fribourg. O.
Société havraise d'études diverses.
BIBLIOGRAPHIE méthodique de l'arrondissement du Havre.* Le Havre. Q.
RECUEIL des publications.* Le Havre. Q.
Société les amis des sciences et arts de Rochechouart. — See Amis etc.
Société linnéenne de Paris.
BULLETIN mensuel. [Paris]. O.
Société linnéenne du Nord de la France.
BULLETIN.* Amiens. O.
MÉMOIRES. Amiens O.
Société neuchateloise de géographie.
BULLETIN.* Neuchatel. O.
Société neuchateloise des sciences naturelles.
BULLETIN.* Neuchatel. O.
Formerly Société des sciences naturelles de Neuchatel.
Société scientifique de Bruxelles.
ANNALES.* Louvain. Q.
Société scientifique et médicale de l'Ouest.
BULLETIN.* Rennes. O.
Society of American florists and ornamental horticulturists.
PROCEEDINGS.* [Boston]. O.
Southern California academy of sciences.
BULLETIN.* Los Angeles. O.
SOUTHERN drug journal.* Atlanta. Sq. F.
Southwest. — See Practical fruit grower.
Springfield, Ill. Pleasure driveway and park district.
ANNUAL report of the board of trustees.* Springfield. Q.
ST. LOUIS lumberman.* St. Louis. $F^4$.
State of Missouri. — See Missouri.

State of Oregon. Board of horticulture.
BIENNIAL report.* Salem. O.
Stockholms högskola. Botaniska institut.
MEDDELANDEN.* Stockholm. O.
St.-Pétersbourg. — See Jardin impérial botanique de,.
Straits and federated Malay states. — See Agricultural bulletin of the,.
Straits settlements. Botanic gardens.
ANNUAL report.* Singapore. F.
Formerly Botanic gardens and forest department.
Sud-Est. — See Bulletin de pharmacie du,.
Svenska. — See Kongliga vetenskaps-akademien.
Sydney. Botanic gardens.
LIST of seeds.* Sydney. O.
—— — See New South Wales.
Tarare. — See Société des sciences naturelles . . . de,.
Thenensis. — See Hortus,.
Thuret. — See Villa,.
Tifliskiĭ botanicheskiĭ sad.
DELECTUS seminum.* Tiflis. Q.
Equivalent to Index seminum of earlier list.
TORREYA.* New York. O.
Toulouse. — See Académie des sciences . . . de,. — Société d'histoire naturelle de,.
Tree planting and fountain society of Brooklyn, N. Y.
BULLETIN.* Brooklyn. O.
Trinidad. Botanical department.
ANNUAL report.* Trinidad. F.
BULLETIN of miscellaneous information.* Trinidad. O.
Trivandrum museum and public gardens.
REPORT.* Trivandrum. O.
Tromsø museum.
AARSHEFTER.* Tromsø. O.
Tropenpflanzer. — See Beihefte zum,.
Tuskegee normal and industrial institute.
[Farmers' leaflet].* Tuskegee. O.

Ukrainische (ruthenische) Ševčenko-Gesellschaft der Wissenschaften in Lemberg.

CHRONIK.* Lemberg. O.

SAMMELSCHRIFT der mathematisch-naturwissenschaftlich-ärztlichen Section.* [Lemberg]. O.

Ungarische Akademie der Wissenschaften. — See Magyar tudományos akadémia.

Ungarische botanische Blätter — See Magyar botanikai lapok.

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Bureau of chemistry.

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[University of Vermont. Botanical department].
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Utrecht. — See Provinciaal utrechtsch genootschap.
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Verein der Gärtner und Gartenfreunde Oberösterreichs. — See Mittheilungen über Gartenbau.
Verein deutscher Rosenfreunde. — See Rosen-Zeitung.
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Verein für Naturwissenschaftliche Unterhaltung zu Hamburg.
VERHANDLUNGEN.* Hamburg. O.
Verein für siebenbürgische Landeskunde.
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CATALOGUE des graines.* Antibes. Sq. F.

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